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SAVORGNAN DE BRAZZA.

M. SAVORGNAN DE BRAZZA the explorer, is French only by adoption, having been born at Nice in 1853. On leaving the naval school at Brest in 1870, he offered his services to the Minister of the Marine, and, after the war, was made midshipman of the first class. He then made a voyage of exploration along the west coast of Africa with Admiral Quilio and Commander Duperré. The advantageous results obtained from this expedition induced the French government to send him on a second mission to Africa to further establish the supremacy of France in the rich region that he had formerly visited. It was on this expedition that he signed with King Makoko a treaty that placed the kingdom of the African monarch and those of the lesser surrounding potentates under the protection of France. It was through his mild and conciliating disposition that M. De Brazza obtained so easily and in so short a time so many advantgeous terms from these people, while Mr. Stanley, who had shortly before him visited the same countries and the same chiefs, but who proceeded in a warlike manner and with threats continuously in his mouth, succeeded only in incurring their hatred.

M. De Brazza, after discovering a new route toward the upper course of the Congo, obtained a cession to France of a certain extent of territory comprised between the rivers Djne and Jmpila, thus securing, with the navigable access of the great African river, an immense opening for French commerce, and consequently for the commerce of all nations. Struck by these advantages, and influenced moreover by the general opinion of the public, which was in favor of M. De Brazza's work, the government of the republic could only show itself favorable toward a ratification of the treaty that had been concluded with King Makoko. M. De Brazza returned to France from this second African voyage in July last and received a most flattering reception from the Geographical Society. We are indebted to *L'Illustration* for our engraving.

M. DE BRAZZA'S EXPLORATIONS IN EQUATORIAL AFRICA.

ON the 23d of June, 1882, M. De Brazza, whose name will hereafter be inscribed alongside of the most illustrious of African explorers, gave, in a lecture before the French Geographical Society, the results of his Ogowe mission. Of this we make the following brief abstract from the pages of our French contemporary, *La Nature:*

Two or three days after leaving Franceville, the aspect of the country perceptibly changes. To the clayey soil of the basin of the Ogowe, to its moist valleys, hid beneath thick forests, and to its hills, covered with tall herbage, there succeeds a broken and sandy ground where, here and there, a few rare palm-trees denote the presence of a village. Here is reached the limit of the basins of the Atlantic and interior Congo; and, curious to relate, from the equator up to Stanley Pool, these sandy lines that divide the waters are inhabited by the same tribe, the Batekes, who have been given an exaggerated reputation for cannibalism, but who show themselves peaceable when their monopoly is not attacked. M. De Brazza's party followed one of the routes of these people for some time, and, after passing the Leketi, the southern branch of the Alima, traversed the plateau of the Achicouyas, which is about 800 meters in elevation, and separated from the plateau of the Abomas by the river Mpama. They were soon received by Ngaugo, an independent chief of the Achicouyas—a race of quite fine looking men who were cleaner and better clad than the Betekes. No less curious than peaceable, these people surrounded the party with shouts of joy, and accompanied it by hundreds across the fields of Indian corn, manioca, tobacco, and peanuts which covered the whole country. The same reception awaited the explorers on the other side of the Mpama, among the Abomas, whose country was less cultivated than the preceding. Trading in slaves, the manufacture of very fine fabrics from palm fiber, and navigation are the principal resources of the Abomas.

These blacks spoke to M. De Brazza for the first time of the Congo River, which is here called the Oloumo, and over which rules the powerful chief Makoko, of whom they are dependents.

The explorers had followed the river Lefini but a short distance, and had just built a raft, when a chieftain, wearing the distinctive collar of Makoko's vassals, presented himself before M. De Brazza and informed him that he had been sent by his ruler to act as a guide. M. De Brazza would gladly have stopped to pay a visit to Makoko, but not knowing exactly where he resided, and fearing to make too great a detour, he continued to descend the Lefini on his raft, accompanied by the envoy.

Reaching Ngampo, the party left its raft and marched for two days over an uninhabited plateau. Burned by the sun, having several times lost his road, and believing himself lost, M. De Brazza was beginning to threaten his guide, when, at eleven o'clock at night, after a final forced march, his eyes caught a glimpse of an immense sheet of water. The Congo, coming from the north-east, where it appeared like the horizon of a sea, was flowing majestically at his feet.

M. De Brazza's object was to make peace with the Oubandji, who are known under the different names of Apfourou, Bafourou, Achialoum, Agnougnou, etc. It would be out of place to translate some of these names otherwise than into Latin. That of Alhialoumou (Congo boatmen) is well merited by those Oubandji who are born and live and die with their families in the beautiful pirogues on which alone they transport ivory and merchandise between the upper Alima and Stanley Pool. It is with their chiefs—masters of navigation, so to speak—that it was necessary to treat.

The chief of Ngampey exhibited a kindly disposition, and took it upon himself to transmit M. De Brazza's propositions to the Oubandji chiefs.

"Choose," said M. De Brazza, in his message to the latter,

SAVORGNAN DE BRAZZA.

"between the cartridge and the flag. The one shall be the sign of a merciless war, and the other the symbol of a peace as profitable to your interests as to our own." After sending this message, M. De Brazza and his party proceeded to pay a visit to King Makoko, who had expressed a desire to receive him, and with whom he remained twenty-five days, and still longer within his possessions.

The result of this visit was that a treaty was concluded, by the terms of which Makoko placed his states under the protection of France, and made a concession of such territory as the latter might select on the banks of the Congo.

Some days after the signing of this treaty, a fleet of magnificent pirogues, each fashioned out of a single tree-trunk, and carrying as many as a hundred men, descended the river and landed opposite Ngombila. All the Oubandji tribes of the eastern basin of the Congo, between the equator and Makoko, had taken care to be represented at this palaver, whence was to issue either peace or war. The assembling of these forty chiefs, clad in their most beautiful costumes, was truly an imposing spectacle. The discussion was long, for many different interests were at stake; but a favorable treaty was finally signed, and the foundation of the French station on the Congo forever secured. Not wishing to join in the fetes given in their honor, the explorers descended the great river in order to put a last finishing touch to the work so happily effected. The descent was made in one of those beautiful pirogues already mentioned, and which is shown in the cut on page 5897.

The party landed at Libreville on the 15th of December, 1880. Here a sad disappointment awaited them, for neither Dr. Bellay nor the *personnel* of the stations had arrived. In doubt as to their coming at all, and unwilling to abandon his stations and the brave men that he had left at from 800 to 1,200 kilometers in the interior, De Brazza, twenty four hours after his arrival at the Gaboon, set out again with his little band, increased by two boatmen and several native carpenters, gardeners, etc.

While he was leaving Ntamo, M. Michaud was descending the Ogowé the second time with his flotilla of pirogues, and had now already been at the factories of Lambarene for a month and a half. Here the boatmen, discouraged at seeing no one come, were threatening every day to return home, when all at once De Brazza's little band made its appearance. On the news of his arrival, the slaves of the Gallois and Inengas came in crowds to ask for refuge; but want of resources forbade a granting of the request. By the establishment of new stations, says M. De Brazza, the question of slavery would be solved in this rich basin, where the palm nut is disdained, as are also the most precious woods (redwood, ebony, etc.), and where the trade in ivory and rubber yields nearly 1,000 per cent., and where the whole face of the country is covered with forests of rubber trees!

At the falls of Bowe, De Brazza's pirogue capsized, and, as he had to work a long time in the water to save its cargo, he contracted a dysentery which has never entirely left him. Besides this, he injured his foot so that he was laid up for two months, and when he arrived at Franceville in February, 1881, he was the first traveler to whom this hospitable station had rendered service.

Relations having been established on an excellent footing with the neighboring tribes, it became necessary to open up a road 120 meters in length, the distance separating Franceville from the confluence of the Obia and Lekiba, the point chosen for the launching of a steamer. After again exploring the country in order to choose the best route, De Brazza quite easily procured the services of four hundred laborers. Squads of excavators and terrace makers were organized, having at their head the Gaboonians, in the character of directors of bridges and roadways, directed by the engineers Michaud, Amiel, and Guiral; and work was then begun.

The difficulties that had to be overcome in order to construct this road are unimaginable. After the trees had been cut down, the earth dug out, and the ground made level, the work, which had been executed with so much trouble, was destined to be soon greatly damaged; for the elephants, observing this long passage through the forests, gave themselves up to their frolics therein, to the ruin of the embankments, which were unable to support their weight. So the work had to be gone over again.

Fearing that commerce might take the land route from Franceville to Ntamo, the tribes inhabiting the river shores now called on M. De Brazza and held a long palaver, at which were present all the chiefs within a circumference of fifty kilometers. The result of this conference was that M. De Brazza obtained all that he desired for the installation of a station on the Alima and a freight line between this river and the Ogowe. This occurred in September, 1881. M. De Brazza, being too sick at this time to return to Franceville, sent one of his men thither for medicines and to give information that all was ready for the exploration of the Alima, thinking that his companions, who had been expected two years, must have arrived. But in this he was deceived, for only one person, M. Mizon, had reached the station, Dr. Ballay having been involuntarily detained at Gaboon.

Along about the 10th of October, De Brazza was enabled to return to Franceville, where there was nothing left for him to do but put into the hands of his successor a work of which France has now only to reap the benefit. Here ended M. De Brazza's part and responsibility.

THE UTILIZATION OF WASTE.*

By P. L. SIMMONDS.

I MAY, perhaps, be deemed egotistical in bringing forward a hackneyed subject, one which I have often discussed before this Society, but in the long lapse of years, in some of its features, it may be new to the present audience. As, in a business point of view, stock-taking is an important feature, I cannot but think it will be curious and useful to ascertain the progress that has been made in many of the important branches, to which I directed attention, since I first introduced this subject to the Society, twenty-eight years ago. I propose to classify the information I have to deal with under the three broad divisions of animal, vegetable, and mineral.

* A paper recently read before the Society of Arts, London.

In the last quarter of a century very important progress has been made in our home industries and foreign commerce; but certainly, the success that has been effected in the utilizing of waste products, and developing neglected ones, is not the least remarkable of recent scientific advances.

It is evident that, when considered from the point of view of industrial science, the phrase, "utilization of waste," may be fairly applied, not only to the unused residual products of manufactures, but to the boundless, undeveloped wealth of nature. The beautiful aniline dye, produced from the tar of gas works, is not more an example of the utilization of waste than beet root sugar, obtained from what, a century ago, was a weed growing by the sea-side. Nature produces abundantly and spontaneously, in many countries, vegetable substances (such, for instance, as the esparto grass) which were long allowed to run to waste. Important industrial uses have been found for many of them, and fortunes realized by numbers who have turned their attention toward rendering them articles of commerce.

ANIMAL WASTE.

The flesh of domestic animals fit for food is almost a waste substance in many countries, since it cannot be locally consumed nor profitably preserved. In the River Plate republics alone there are 80,000,000 sheep and 25,000,000 cattle to a population of 2,500,000. For years, sheep were only valued there for their wool, and, when flayed, carcases were left to rot, or, when dried in the sun, piled up in stacks for fuel, while later on they were boiled down for their tallow. Sheep get very fat in the province of Buenos Ayres, and those of three and four years will give frequently from 18 to 25 lb. of tallow. Countless numbers of sheep are boiled down every year in the so-called "graserias" only for the tallow, which forms one of the staple articles of export. The mutton is thrown away, or used in a dry state as fuel.

I alluded in my first paper to the countless herds of so-called buffaloes, the bisons, which were hunted in the prairies of North America, chiefly for their skins or furry "robes." At least half a million were killed yearly, but of late the flesh and the bones have been collected and utilized. A recent law of the United States, however, prevents the wholesale slaughter of these noble animals, for fear of the utter extermination of the breed.

In the five years ending with 1850, more than 1,500,000 sheep and 200,000 horned cattle were boiled down simply for their tallow, in the colonies of New South Wales and Victoria.

We are great meat eaters in this country our average consumption being 120 lb. per head, or double that of the people on the Continent; and as our home supply is quite insufficient, we have to import more than 600,000 tons every year. With the growth of our population, and the decreasing number of live stock at home, the imports of meat from abroad have prodigiously increased in the last quarter of a century. In 1856, our imports, including fresh and salt meats, hams and bacon, and live cattle, were only of the value of £3,233,587, while in 1881 they had risen to £24,754,000.

In a paper read before the Royal Colonial Institute last month, by Sir Francis Bell, the Agent General for New Zealand, he stated that frozen meat in any quantity can be placed upon this market from the other side of the world at 6d. to 6½d. a lb., leaving a good profit to the grower. "This (he added) ought ultimately to make meat cheaper here, or at least prevent the further rise now threatened. Australia and New Zealand can, in fact, export 700,000 tons of meat a year, or 2,000 tons a day, which is not much more than you want in England even now, without reducing even the present capital number of their sheep and cattle; and we are able to send on sheep to Smithfield with greater ease today than the Tweed farmers could one hundred years ago, when meat was selling at a penny a pound in Scotland against tenpence in London.

Horses, although numerous in some countries, as in Russia and the River Plate states, have not been commercially very useful when dead. In South America mares are never broken to the saddle, and the carcases are generally boiled down for their fat, the exports of mares' grease being considerable, while the hide is also useful. But, within the period now under our notice, horse flesh has come largely into use on the Continent for human food.

Since 1860, when the first slaughtering of horses for food took place in Paris, under the patronage of the "Society for Promoting the Use of Horse Flesh," the consumption of this meat has been steadily increasing. The sale of horse flesh has become a legalized and recognized trade in many of the Continental States especially in France and Germany. The published statistics of that society show that, since its foundation in July, 1866, 160,480 horses, 6,690 donkeys, and 395 mules had been sold in Paris alone for food, up to the end of 1881, furnishing 67,809,430 lb. of meat. Horse flesh is sold at half the price of beef. The innovation has gained ground rapidly in most of the principal towns of France, and the public sale of horse flesh for human food is now general in Austria, Prussia, Bohemia, Saxony, Hanover, Switzerland, Belgium, and Sweden. In this country we are more fastidious in our eating, and although efforts have been made to introduce horse flesh as food, they have not succeeded. The hundreds of horses which die in the metropolis are sent with other carcases to special firms, which utilize every part commercially. The skin is removed, and the bones are taken out with great expedition; the flesh is then placed in caldrons of a capacity of 600 gallons. Upon boiling the flesh, the oil is separated, and used by soap makers and leather dressers. The bones are also boiled, yielding further oil and fat, and are afterward utilized for manure.

In the United States there was formerly a plethora of waste. The time was when, in Cincinnati, Chicago, and other slaughtering centers, the food of millions was cast out and allowed to be entirely lost by being thrown into the river, or burnt in large pits. Several years ago, one of the most extensive slaughterers asserted, and he had good reason for knowing, that in Cincinnati as much was wasted in one day during an active season as would feed all the inhabitants of Paris for a week. At that time, indeed, all the heads, feet, intestines, and much of the lard of the hogs were cast out. Now such is not the case, for the poor but industrious German and Irish populations have saved much of this extravagant waste, and, by their cheaper labor, almost the whole of these substances has been converted to profitable use. Even now, a great deal of the ox is disused which, in Europe, is esteemed most nutritious food. One cannot obtain in America a bowl of ox tail soup in private houses, and very seldom in hotels and restaurants. It costs too much labor to separate the rich gelatinous tail from the hide. Ox tripe is sold in the Cincinnati markets, but the liver and heart are most frequently buried, or allowed to be swept away with the blood. And the blood of the tens of thousands of cattle, and hundreds of thousands of hogs, each season slaughtered, is never saved, but runs down the open gutters until it mingles with the water in the river.

There is an important industry which has sprung up out of animal waste, in the utilization of purified tallow and other fats for food and domestic purposes. It was originated in France in 1869, by M. Mége, and was intended for the manufacture of artificial butter from fat, by extracting the oil at a low temperature, and converting this by churning into butter. It was first known as oleomargarine, then as margarine, and latterly as butterine. The manufacture of this product has spread extensively, and it is carried on in the United States on a very large scale. As a London trade journal observed, a few weeks ago, "It is to be regretted that shop keepers do not see their way to offer it to the public under its proper name, a proceeding which would be not only more honest, but which would ultimately tend to the more general adoption of butterine as an article of daily consumption."

From statistics prepared by Mr. Nimmd, of the United States Department of Agriculture, it appears that more than one-third of the American exports of butter are sworn to be oleomargarine. Now, as we receive over 8,700 tons of so-called butter from North America, it is not pleasant to know that one-third of this is the artificial butterine. Not only is margarine thus used, but, under the name of suetine, much lard is now introduced into the butter.

In the utilizing of inferior or waste materials, and in the separating of tallow from the substances with which it is found in combination, machines are employed which are both ingenious and effective, and by their use much material that would otherwise be worse than useless is turned to good account.

In Europe, rabbits are not a waste substance, but are eagerly sought for as food, and even bred in large quantities; but their introduction into Australia and New Zealand has proved an unmitigated evil to the colonists. About twenty years ago there was not a single rabbit in Australia, save, perhaps, a few domesticated pets. Since their introduction, they have become a perfect pest, and the difficulty is to exterminate and keep them down by poison, dogs, etc.

From New Zealand, alone, 8,500,000 rabbit skins were exported in 1880, but this does not probably represent one-tenth part of those actually destroyed. In that climate the rabbit breeds nearly every month in the year. But even supposing that a pair of rabbits do not breed oftener than in England, which is seven times a year, and that they only bring eight young at a time, they would multiply in the course of four years to 1,250,000. Besides the skins shipped to England and America, the colonists are trying to send us their flesh in tins.

Rabbit skins are in demand by the furrier. About thirty million indigenous rabbit skins and two or three million hare skins are used up in this country. The skins of those which are not used or dyed as furs are, after the hair has been pulled for the hat maker and for stuffing beds, employed for glove making. The hair is also now used for making yarn and cloth.

The wool manufacture in almost all countries now uses up cuttings of cloth and shreds of all kinds which were formerly thrown away. These and the strippings and waste in carding are now classed immediately after pure wool, and command relatively high prices.

There are many who may be disposed to regard the shoddy manufacture as a business to be despised, but the political economist discovers in it a most important source of wealth —wealth resulting from the application of skilled labor to the utilization of material once worthless, but now contributing no mean sum annually to the wealth of nations. The shoddy manufacture would seem to have originated at Batley and Dewsbury, about fifty years ago. It was only in 1861 that we commenced to import woolen rags, about 7,000 tons being received. In 1881, the imports were 35,000 tons, valued at £701,000. There are two distinct terms used in the rag-wool industry: (1) "shoddy," which is the product of soft woolen rags, such as stockings, flannels, shawls, etc., torn by machinery into fiber suitable, when mixed in certain proportions with wool or cotton or both together, to be re-spun into cloth; (2) "mungo," which is a variety of the same material, firmer, but much shorter in staple, obtained from hard woolens, such as broadcloths, tailor's clippings, etc. The average price of shoddy is about 4d. per lb., and that of mungo about 6d. Noils and waste are obtained principally from Bradford, where spinning and power loom waste are produced in considerable quantities, and though refuse in the Bradford trade, they serve a useful purpose in the shoddy manufacture. There is a third product utilized, known as "extract wool," which is obtained by a chemical process which destroys the cotton in union or mixed fabrics, leaving the wool uninjured. This process of destroying the cotton by the use of acids was discovered about twenty years ago, and is carried on both in Great Britain and the United States.

There are now 137 shoddy factories, principally situated in the Yorkshire district, which employ over 5,000 persons, 3,000 of whom are females. About 40,000 tons of woolen rags are annually torn into shoddy in England alone, and the quantity made in the United States must be almost equal. No accurate data can be found of the European use of these articles, but an immense quantity of both shoddy and mungo is now made and exported from the Continent, principally to England, and it is probable that the whole of the world's annual consumption is over £7,000,000 in value. At the recent International Wool Exhibition, held at the Crystal Palace under my charge, there were shoddies sent from most of the States of Europe. Italy first began to work woolen rags into yarn in 1858, and most of the other European countries followed the example.

Let us pass to another important manufacture—silk. Nine years ago, in an article in the *Journal*, I drew prominent attention to the increasing employment of silk waste, and I therefore need not go into any very full details. But still the subject deserves passing notice from the trade importance it has attained. Raw silks having become scarce and dear of late years, much more attention has been given to the employment of the different sorts of silk waste, for which, at one time, scarcely any use could be found.

The variety of these is very large, and most of them are now profitably and extensively employed. The outside and inside husks of the cocoons used to be mere refuse. These pass under various trade names in different countries; in England, as "knubs and husks" and "floss silks;" on the Continent, as '*bourre de soie*," "*frisonets*," and "*floret*." What is termed "yarn waste" is the waste made by the silk throwster. The pierced cocoons that have been eaten through by the moths are now largely employed in the preparation of "chappe" or "schappe." Then there are the noils and thread waste from the silk factories.

In 1857, the imports of these waste silks were only 18,000 cwt., valued at £302,286. In 1881, the imports reached 540,119 cwt., valued at £757,796. France, Switzerland, Germany, Great Britain, and the United States have now entered extensively into the utilization of silk waste for manufactures, which was formerly a drug in the market. In the Swiss report on the Paris Exhibition of 1867, it was stated that the annual production of floss silk yarns then ranged in value from £400,000 to £600,000. In 1872, about 7,750,000 lb. of thread were made from waste silk in Europe. In the United States, 2,000 to 3,000 bales of waste silk are used up annually, valued at £200,000. Italy exports annually about 5,000,000 lb. of silk waste. At Manningham, near Bradford, Messrs. Lister & Co. have one of the largest silk factories in Europe, chiefly engaged in manufacturing articles out of waste silk that are scarcely, if at all, made elsewhere in England, such as velvets, hat plush, and ribbon velvets.

There are fifteen establishments in France, with 479,353 spindles, working up waste silk, that is, the waste from the cocoon not reelable, the short pieces, etc. What remains over from this working is again used up by seven other factories, which by means of further combing and carding, employ waste formerly only partially utilized, or altogether lost to consumption.

I connection with this subject, I may draw attention to the stimulus given to the collection of the cocoons of the wild silk-worm of India, known under the name of Tusser. These, which were formerly only used in the East for making a kind of drab or coffee-colored silk, have now, through the exertions of the Indian Government, and the skill of Mr. T. Wardle, of Leek, been made to take dyes, and are profitably employed in the silk manufacture in England. The waste of the wild cocoons in China and Japan is made into felt for hats, and enters into the manufacture of paper.

The improvements in machinery for the preparation and spinning of silk waste have made great strides of late, and whereas a few years ago one never heard of anything but "spun silk" hosiery, handkerchiefs, or some other little article of similar make, the whole world now knows the "schappe" velvets of Crefeld, the "spun" ribbons of Basle, and the laces of Nottingham, while the king of silk spinners—Lister of Manningham—has even produced machine twist of excellent quality from this unlikely material.

Let us look at the supply of raw material, and compare the facilities of twenty-five years ago with those of to-day. Then the European spinner had simply the choice of Canton gum waste, China curlies, Bengal chassum, Persian balls, or Italian knubs and gum, with what little engine-waste he could obtain from the throwsters of China raw silk here. This last, indeed, was often so lightly valued by the owner of the throwing mill, that the operatives were allowed to use it for cleaning machinery. Now we find that Japan alone furnishes at least four well-known kinds, pierced cocoons, knubs or curlies, the inferior outside layers of the cocoon, winder's waste, and floss silk, known among merchants as "caps," being the sheets used to protect the ends of the books or bundles of silk.* The export of this silk-waste from Japan exceeds 27,500 cwt.

The refuse from the tanneries, now so profitably utilized, is of considerable importance; it consists of untanned dried pelt or glue pieces, fleshings, hair, lime deposit, and spent-tan. Glue pieces or "scrolls," as they are termed, are sold to the paper maker, and scores of tons for the manufacture of gelatine and portable soups. Ordinary size is made from the fresh refuse from the hide, and is extensively used by paper-hangers, cotton spinners (to give firmness to the thread), and carpet manufacturers. One firm of tanners makes £1,000 a year out of their fleshings from hides. Ladies may be interested in knowing that the so-called cheap seal skins are manufactured in the north of England from common plasterer's hair, or that obtained from the tan-pits. The spent-tan or bark—about 250,000 tons—has not yet found very profitable use. Some have tried to turn it into charcoal, and light their tanneries with its gas, but with slender success. Liebig had shown that both this, and the lime-grounds or deposit, are useful as manure. There has been made for many years, in Germany, printing-paper and cardboard of the waste bark from tanneries. The common papers receive about 10 or 15 per cent. of this pulp; the boards for roofing from 20 to 40 per cent.

Artificial leather is also now extensively made from leather cuttings, pressed and rolled into sheets with some glutinous composition.

Latterly, it has been found that leather waste-cuttings, etc., when steamed with certain waste liquors, produce a valuable material in the shape of a new black, which is destined to have a variety of important uses, such as in the manufacture of printing inks, dark pigments, covering substances, and notably for the manufacture of blacking. Bone-black, from which the latter is chiefly made, costs £9 per ton, and the supply is limited, while this new tannic black can be sold at one-third of the price.

The blood from the slaughter-houses, which used to be wasted, is now collected in Europe, and utilized for manufacturing into blood albumen, which sells at about 1s. a pound. The drainings and the clot go for manure. In France, the quantity of blood resulting from the animals slaughtered is estimated at 177,000 tons; but they do not yet utilize it so generally and advantageously as we do, it being chiefly employed as a fertilizer for land. In Spain, the quantity of blood for animals killed reaches half the quantity named for France.

Among the miscellaneous animal substances now utilized, we find many species of fish skin tanned, such as the so-called porpoise skin (*Beluga catodon*). Alligators and crocodiles, and even snakes, are hunted for their skins, which are tanned, and provide a valuable article in making slippers, purses, pocket-books, cigar-cases, etc. One tanner at St. Louis, America, is stated to have received recently 5,000 alligators' skins.

Great progress has been made in the period under review in the manure trade, both as regards natural and artificial fertilizers. In a recent official report made to the French Legislature, the trade in manures in that country was valued at £3,000,000. In England, it would be very much more. We do not receive so much guano as formerly, for while in 1840 the imports were from 250,000 to 300,000 annually, they have now dropped to about one-fifth of this amount.

In view of this deficient supply, we are obliged to look to other sources. Thus, our imports of bones and other substances used for manure were, last year, of the value of £1,565,801. A large trade is done in artificial manures sent to the north of Europe, our sugar-producing colonies, and the Cape of Good Hope.

Even in Australia, the large accumulation of bones and

* Japan Weekly Mail.

other animal refuse from butchers', boiling down, and meat-preserving establishments, has led to the creation of extensive factories, for converting these waste products into valuable fertilizers. The manufacture of these artificial manures is now conducted on a very large scale, and a considerable local and export trade has resulted therefrom.

VEGETABLE WASTE.

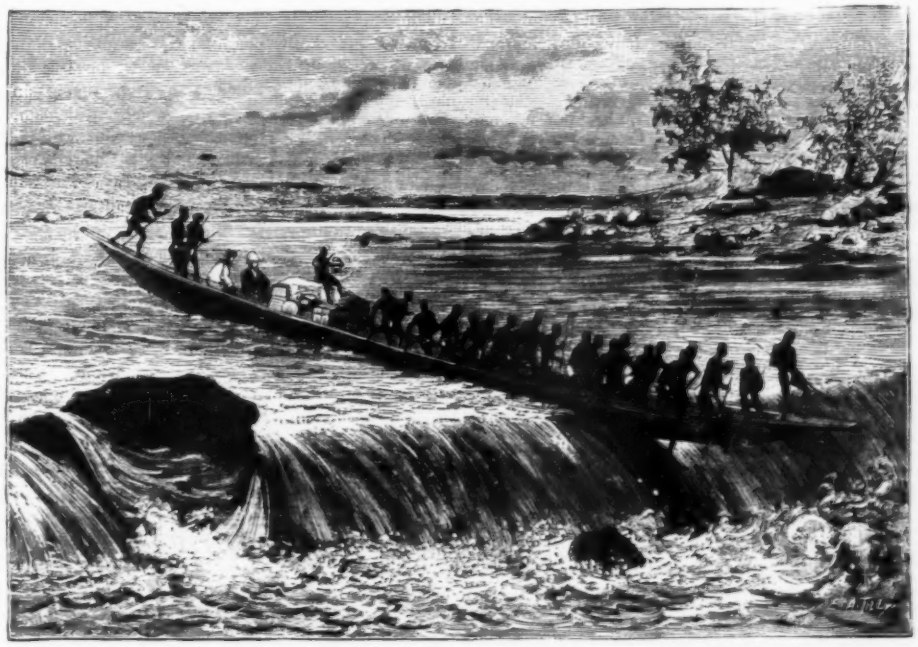
Let us pass now to vegetable substances, and I will first consider the paper manufacture. A recent estimate was published, which set down the paper-mills of the world at 4,000, producing 1,000,000 tons of paper, of which the half was used for printing.

The quantity of paper of different kinds now made in the United Kingdom probably exceeds 350 million pounds annually. The newspaper press alone has made enormous strides, to say nothing of books, periodicals, and other printing demands. A quarter of a century ago, there were scarcely twenty or thirty daily issues of newspapers in the Kingdom; now there are at least 140, many of them papers with very large circulations.

In 1856, we received but 10,284 tons of rags for paper-making from abroad; in 1881, we imported 26,773 tons. esparto grass was only introduced to any extent in 1861, when 891 tons were received. In 1881, the imports had risen to 192,493 tons, valued at £1,286,211. Besides this, we also imported 45,550 tons of wood-pulp and other paper-making substances.

It is now evident that the future of the paper industry will, in a large degree, depend upon the use of wood, which is already so extensively employed. For the ordinary varieties of paper ground wood is used; but for the finer sorts, chemically prepared wood-fiber, or cellulose, is employed. The practical process for the preparation of cellulose was discovered in 1852, and numerous other processes or improvements have since been invented. It comes into commerce in two forms—wood pulp in sheets or blocks, and ligneous meal or wood flour.

In central Russia, aspen wood is most extensively employed; in Sweden and Finland, spruce and fir, which afford the longest fibers; in Germany, France, and Belgium, mixed woods. The pulp from beech and birch woods has too short a fiber.



DE BRAZZA PASSING OVER A RAPID ON THE OGOWE. (See first page.)

About twenty years ago, some of the American papers used the bamboo largely for making paper. This is no new application, for the Chinese have long employed it for a common description of paper. Of late years, however, Mr. Thomas Routledge, of the Ford paper mills, Newcastle, who was the first to utilize extensively esparto grass, has prosecuted extensive researches and inquiries, so as to extend the supply of this excellent paper material. It may be mentioned here, that the number of the Society's *Journal* (Nov. 28, 1856) containing Dr. Royle's paper on Indian fibers, was printed on paper made by Mr. Routledge, entirely of esparto.

The fibrous stem and leaves of the plantain, which is so plentiful in most tropical regions, have not yet been practically utilized, although efforts were made some years ago in British Guiana by a company. Dr. King, the Colonial Botanist at Calcutta, recently reported: "It has been found that, during the dry months, simple exposure of the sliced stems to the sun is sufficient to prepare the fiber for paper-making, provided the paper mill be on the spot. What is still wanted is some cheap mode of removing the cellular tissue, so that the fiber may be shipped to England without the risk of fermentation on the voyage."

A good deal of the jute sent from India to the United States consists of the dark root, or butt ends of the fiber, which are cut off when the jute is pressed into bales. These are called "cuttings" in Calcutta, and with us "rejections;" they now form a regularly quoted article of export to America, where they are employed in the fabrication of various shoddy-stuffs. In former years these cuttings were thrown away.

The *Dundee Advertiser* of the 14th May, 1873 was printed on paper made from jute, and in the issue it was stated: "This is the first paper, as far as we are aware, ever printed on jute. Being in the center of the jute manufacturing district, we have been anxious, for some time, to print on the material which has now become the staple of our local manufactures, and we are indebted to our principal paper-maker, Mr. D. M. Watson, of Bullionfield, for carrying out our wishes. It may be explained that this sample is made almost entirely from old jute bagging." To some extent, jute bagging and waste have now been used by paper-makers for several years.

Other waste substances are coming into use with the paper trade, where obtainable in quantity and cheap. Megass, the refuse stalk of the sugar-cane, makes excellent paper. The husks of oats, barley, rye, and rice are also used alone, or combined with other materials.

Straw board, of late years, has been found to be a cheaper material than the old-fashioned "pasteboard," and it has come extensively into use in America for paper-boxes. The annual product of straw-board in the States is from 35,000 to 40,000 tons.

Straw has long been employed as a paper material, but it is often scarce and dear. It is even found profitable to buy up the bedding litter from the metropolitan stables, and, after washing and disinfecting it, to sell it to the paper-mills. The last United States census (1880) showed that more than 270,000 tons of straw were used for paper.*

By the patent process of Chadwick and Clench, the carbonate of soda is recovered from the waste liquors, resulting in the reduction of fibrous materials, when manufacturing paper pulp from straw, esparto grass, hemp, jute, and other fibrous materials.

In a paper read last year before the Scottish Society of Arts, by Mr. G. J. Wishart, on the recovery of soda from the spent lye of the paper-maker, he observed:

"The industrial progress of recent years has in no direction been more marked than in the utilization of waste materials. New industries have thus been created, and old ones rendered more profitable, while grave public nuisances have, in many cases, been removed or abated.

"Were it not for the by products obtained from what was once considered waste in the manufacture of paraffin oil, it would be impossible for the manufactured oil of this country to compete with the ready made article of the American wells. By a similar utilization, gas—the product primarily sought for in the distillation of cannel-coal—can, it is said, be manufactured free of cost; while, in the paper industry, the chemicals employed in the process of converting esparto and other raw fibrous substances into paper pulp are now, to a large extent, recovered, and are thus kept out of the streams they formerly polluted, to the manifest profit of the manufacturer, and the satisfaction—so far—of riparian proprietors."

Until a very recent period, the waste paper of the Government offices of London was the perquisite of the messengers. But when it was found that the aggregate sales of this waste paper reached the sum of £10,000 to £15,000 a year, it was thought time to look into this, and it was then handed over to the Stationery-office, and, in the last financial year, the sale of waste paper reached £11,771. Unfortunately, the Government printing is very lavish, every member receiving about a ton weight of Parliamentary documents yearly. The United States Treasury sells yearly more than 600 tons of paper pulp, resulting from the destruction by maceration of Government securities, bank-notes, etc.

In one large printing and publishing establishment in the metropolis, the waste paper in shavings and imperfect impressions exceeds 75 tons a year. Even the newspaper offices now economize, and use up their spoiled impressions or overplus papers for printing their posters on.

I might enlarge upon the extension of the trade in fibrous substances, formerly waste, used for brushmaking, such as kittool, piassaba, Mexican grass, etc.; but there is a gentleman present who can supply better information, as he was the first to introduce them.

It is only since 186[illegible] that the extraction of the oil from cotton seed has been carried on on a commercial scale; before that date vast quantities of the seed were allowed to accumulate and to rot on the cotton plantations. It is an industrial fact of considerable interest and significance, that at the present time the seed is often more valuable to the planters for its oil and oil-cake than the cotton fiber, for of the latter it contains only about one-quarter of its weight.

Decorticated cotton cake, largely used for cattle food, is of a pure yellow, and is made only in England and America. The seeds are crushed in the decorticators, and the husks removed from the kernels by winnowing. The kernels are next ground and made into cake in the usual way. The husks are utilized in paper-making. If the oil is to be used for industrial purposes, the cakes are hot pressed, but oil for table use is always obtained by pressing in the cold.

The total production of cotton seed in the United States has been estimated at more than two and a quarter million tons, but there are other sources from whence supplies are drawn, such as Egypt, Brazil, and India. Not many years ago, our imports of cotton seed into the United Kingdom were only 80,000 to 100,000 tons. In 1881, we received over 232,000 tons, of the value of £1,783,109.

In France, large supplies of cotton seed are received from Turkey, Egypt, and Italy. Marseilles and Rouen are the leading towns in which the seed is crushed, and the oil, so expressed, is used by painters, varnish makers, and soap manufacturers; combined with other oils, it is used for lubricating, and now also extensively as a substitute for lard for household purposes.

It is stated, in an American paper, that there are now in operation in the Southern States sixty-seven cotton oil mills, and the price of cotton seed has advanced from six to twelve dollars per ton. Over £500,000 worth of oil was manufactured last year; this, however, is declared to be but a mere fraction of the value of the whole crop, were it all utilized. The American cotton crop of last year produced about three million tons of seed. Of this, no more than 180,000 tons, or one sixteenth of the whole, were crushed. The 2,800,000 tons which went to waste would have produced ninety-eight million gallons of crude oil, worth forty cents. per gallon, or more than £8,000,000 in value.

In the process of refining, the residue of the crude oil is distilled, and, with care, produces a hard grease or stearine, which commands, when of good color, within 3s. or 4s. per cwt., the price of Petersburg tallow. This by-product is used for making artificial butter. Even the foots, or tarry residue, is useful as a paint ingredient. Cotton seed oil is now largely mixed with olive oil. Its presence may be recognized by treating the oil with nitric acid; on shaking it, a coffee brown color will be seen if cotton seed oil is present.

Although the olive is a most important product of Italy, Greece, and some other countries, the means generally employed for extracting the oil were very imperfect, and led to considerable waste of oil. After the olives had been crushed by the peasants, the husks were abandoned as worthless. Until the last seven or eight years, the residue from the oil presses was either used as manure, or more usually burnt as fuel. It was largely exported from Corfu to Malta, where it fetched remunerative prices, being used by the bakers to heat their ovens. The accumulation of this material in the Ionian Islands had become enormous, in spite of the local consumption, when it occurred to some one to analyze it, with the view of turning it to some useful account, and it was then found to contain a large percentage of useful oil. At Corfu alone, from 350 to 400 tons of this oil, extracted by bisulphide of carbon, is now shipped to Marseilles, and used for soap-making. The crude product, freed from the nuts, contains about 25 per cent. of fatty matter, and the cake, as received from the press, with the nut-shells still in, contains about 13 per cent. of fatty matter. The husks are now imported in large quantities to Marseilles, where, by chemical means and a steam press, 20 per cent. of oil is obtained. The nuts of the olive, which were formerly thrown away, now yield, in Greece alone, oil to the value of £20,000. These improvements have been effected within the last fifteen years. At Tunis, small bits of the olive skins, after the oil has been extracted, are mixed with wheat and barley, and made into bread.

On the West Coast of Africa, in the production of palm oil from the fruit of drupes, the kernels were formerly thrown away; now they are cracked by hand with stones by whole villages. In 1863, it was found profitable to collect and ship them for the oil, of which they yield about 30 per cent. From the single port of Lagos about 45,000 tons of these kernels are shipped, valued at £500,000; from Sierra Leone 10,000 tons, and other quantities from the Gold Coast. It has been estimated by competent authorities that, from the 50,000 tons of palm oil shipped from Africa, there must be 223,000 tons in weight of kernels, which would yield as much more oil as is already shipped. In fact a competent authority, Mr. C. Sevin of the "Palm Nut Oil Mills," estimates that we ought soon to get 400,000 tons of palm nut kernels from West Africa. The marc, or residue after the expression of the oil from nuts and seeds, if not exactly a refuse material, is at least a secondary product in the manufacture which possesses considerable value, and has become a large article of commerce for feeding stock and manuring land. Among the oil cakes chiefly used for cattle food are linseed, rape seed, decorticated cotton seed, ground nut, and cocoa nut, mustard cake, rape cake castor oil cake, undecorticated cotton seed, and some others are used for manure. Besides the quantity of oil cake made at home, we imported, in 1881, from abroad, 221,100 tons, of the value of £1,764,492.

One of the raw materials, the most abundant in the production of alcohol, is the molasses from beet sugar. The quantity of molasses annually produced on the Continent is estimated at 250 millions of kilogrammes. Of the 30 parts of non saccharine matter, 5½ per cent. are potash, and 1¾ to 2 per cent. of nitrogen. It was only in 1853 that the distillers first entered on the production of alcohol. The molasses, after yielding alcohol, leaves as residue a brown aqueous liquor known as "vinasse." This, evaporated and calcined by heated air in special furnaces, furnishes the saline of beet root, which is one of the most important sources of potash in France. The pulp of the beet root is largely used for feeding cattle; its value, however, varies according to the process by which the sugar is extracted. The ordinary process is by pressure, the other by diffusion. In the first case, the roots being submitted to rasping, the cells are torn, and the saline and albuminoid matters are mixed up with the sugar in the juice by the action of the press. In the second case, the cells are preserved intact, the beets being cut into thin slices, which are treated with tepid water. The residues from diffusion are almost free from sugar. If in the dry states, they are more rich in albuminoids. About 5 lb. of this pulp is given daily to a sheep, and 50 lb. per head to cattle, in admixture with other food. The pulp is stored for preservation in trenches or silos, and for this purpose it is mixed with about one per cent. its weight of salt, to prevent it from entering into putrefactive fermentation.

There are upward of 40,000 breweries in the United Kingdom alone, to say nothing of the large numbers on the Continent. The best use of the by-products of the brewery is that of the grains for cattle food. As this is very subject to decomposition, various systems and apparatus have been invented to preserve the grains. The old fashioned plan of pressing them into pits or a large tank, with the addition of some salt, in order to preserve them for a time, is well known; but this is not practicable if the grains have to be carried great distances. In 1874, Mr. Henry Chapman took out a patent in America for compressing, salting, and drying

* The whole materials used were:

	Lb.
Straw	540,842,660
Rags	413,417,400
Old paper	199,248,000
Manila stock	186,329,300
Cotton-waste	26,563,600
Corn (maize) stock	2,098,100
Esparto grass	560,800
	1,363,311,408

This is inclusive of the wood-pulp consumed.

the grains, and thus making them into a novel and salable article of commerce. Upward of three million bushels of malt are brewed in New York and neighborhood every year, which yield 16,500 tons of dried grains.

The marc, or residue of hops, according to Boussingault and Payen, contains 2¼ of nitrogen dry, and about 0·56 wet. From the residue of distilleries, from maize by the filter presses and heated cylinders, a large quantity of burning and saponifiable oil is now obtained, and also feeding cakes for cattle, of equal value to those from earth nuts.

Take another instance of utilization in dried yeast; not only is it an important article of import with us from the Continent—206,000 cwt., exceeding £542,000 in value—but it has become an extensive industry in many countries. In Russia, the value of the pressed or dried yeast annually consumed is officially stated at 250,000 tons. They also import about 20,000 cwt. to 22,000 cwt. from Germany and Austria; twenty years ago the import was only 10,000 cwt. A dried yeast is also made from maize in Baden, which differs from the rye yeast of Hanover and Hesse, the compressed beer yeast of France, and the dry yeast of Bavaria, in that it keeps better, and contains a more regular ferment, which renders the bread lighter and of a better taste.

There is one product of the United States which, although scarcely a waste one, is very difficult to use up profitably; that is, maize or Indian corn. This staple crop increases so rapidly that use can hardly be found for the whole of it. Its principal occupation is for fattening the enormous hog crop of the States. It has been used for distilling, and for making starch; but recently a profitable employment has been found by converting it into glucose or starch sugar. When we consider that the maize crop of North America exceeded, in 1880, 1,700 million bushels, any new uses for this abundant cereal become important.

In the States of Iowa, Illinois, and Nebraska, there are often thousands, if not millions, of bushels of Indian corn in the ear, that can neither be sold nor fed to stock, and which have to be used as fuel, for want of means of transport to a ready market, for it takes five bushels of corn to pay for sending one bushel to where it can be used.

Mr. Pakenham the British Secretary of Legation, in his official report for 1873, stated that—

"Between the consumption and exports there is often a surplus of 664 million bushels. Some of this is doubtless utilized, but inquiry from season to season only elicits the reply that, when not burned, it lies over, deteriorating, and is applied to some inferior purpose, or used for manure."

It would be difficult to define the limits to which the indirect consumption of Indian corn extends. Every pound of American pork eaten, the laundry and food starches used, the large production of alcohol (that of whisky in the States is 67 million gallons), the varnishes used by the cabinet maker, the perfumery of the toilet table, the different kinds of illuminating fluids, all indicate the universality of the employment of maize.

It was in 1867 that the new use was found for maize by converting it into glucose. The report of the New York Chamber of Commerce states that the production of this sugar is now not less than 1,000 tons a day for the whole country. A bushel of corn is said to yield thirty pounds of grape sugar, or three gallons of the sirup; and while the sugar costs less than 2d. per pound to make, it is sold at 3½d. and 4d; the sirup being quite as valuable.

In the States, this class of sugar is used most extensively for mixing with cane sugar and cane molasses; while reducing the sweetening power, it produces a whiter and pleasanter appearance in the sugar. Glucose is largely imported into this country, being chiefly used by the brewers, but more recently for confectionery and preserving purposes. Our imports last year of solid and liquid glucose (chiefly from Germany) were nearly 400,000 cwt., valued at £367,000.

In America they are also endeavoring to utilize the immense quantities of pulp remaining from the corn after the extraction of the starch. This pulp, which is at present a waste product, consists wholly of cellulose or woody fiber, and would, it is considered, be an excellent material for making the commoner grades of paper, suitable for wrapping and newspaper purposes.

Potash is a valuable product, obtained from the destruction of wood. Canada used to supply us with large quantities, but her exports have fallen off by one-third. We only received, in 1881, 60,000 cwt. of potash from all quarters; 16,000 tons used to be made, annually, in the United States, but there is not now such an extensive destruction of forests. Throughout Australia, although thousands of tons of timber are burnt annually, the ashes are never lixiviated for the purpose of obtaining potash.

The present sources of the supply of potash are rapidly failing; every year the area of the supply becomes smaller, and the product, in consequence of this and the increased demand, becomes more and more expensive.

The cobs of Indian corn, which are now considered of little or no value, may yet share the same fate as many substances which, though formerly considered worthless, have become new mines of wealth, through the aid of chemistry.

The average yield of 1,000 parts of cobs is 7·62 parts of carbonate of potash, or nearly twice as much as the best specimens of wood, and it is a material which can fill its full measure of usefulness for other purposes before it comes into the hands of the manufacturer of potash. At the shipping ports, large shelling mills are established, capable of running through 500 bushels of corn an hour. Here, then, are the places where a supply of cobs may be procured.

The corn crop of North America varies; but, taking the yield of 1871—1,100 million bushels, at 14 lb. of cobs to the bushel—this would yield 7,700,000 tons of cobs, containing an average of three-quarters per cent. of pure carbonate of potash. The enormous quantity of 115½ million pounds of that useful article might thus be thrown into commerce. In some districts, these corn cobs are extensively used as fire lighters, being dipped into a composition of resin and tar, and then dried.

It is only some twenty years now since glycerine, a by-product in the manufacture of soap and candles, has been produced on a commercial scale, but the quantity now made represents an annual value of nearly a quarter of a million sterling. Glycerine has thus attained to a position of considerable technical importance. The introduction of the stearine candle industry, and the efforts to utilize the heretofore waste products of the soap manufacture, demonstrated its existence in considerable quantity. The important uses to which this substance is now employed are so numerous, that it would be difficult to enumerate them. There are no available statistics to estimate the total magnitude of the glycerine industry of the world, but its extent may be imagined from the fact that, in the United States alone, there is annually produced not less than two million pounds, and in Europe, as is said, about 520,000 cwt.

There is a large consumption of cork bark in this and other countries (the quantity we import exceeds in value half a million sterling), and even in this direction, the economizing of the waste is found profitable and useful. The suberine powder is made into cork carpets for floor cloth, and it is even used by chemists, in place of lycopodium, powdered rice, starch, etc. Old corks are collected, and cleaned with hydrochloric acid and hot water, so as to be used again. The Paris sewers are provided with gratings, and the corks thus collected are recut and used again. All cork cuttings are useful for filling life buoys, belts, jackets, and even beds.

In Europe, as much use has not been made of seaweed as in China and Japan, where it forms a very large article of consumption for food. In China, it is imported both from Japan and Asiatic Russia, to the extent of more than 25,000 tons a year. It is received in two forms: 1st quality, cut, and some known as agar agar; and 2d quality, long. This seaweed is principally consumed by the lower classes of Chinese as a condiment or flavoring with their rice or other food.

Another product into which seaweed is converted is gelose, a sort of vegetable isinglass. Viewed from whatever direction, the more general utilization of seaweed is a most important matter. In some of the northern countries of Europe, cattle are fed on it. Formerly, iodine was only obtained in any quantity from the kelp of seaweed, but it now appears likely that it can be produced in Peru at a comparatively small cost, being a by-product extracted during the process of manufacturing nitrate of soda; while the necessary arrangements for the manufacture of iodine from kelp are very costly, and the works and machinery used require a large sum of money. It is possible that 5,000 or 6,000 cwt. of iodine might be manufactured in Peru at a low cost, but the war with Chili interfered materially with the production. With the exception of the manufacture of kelp, the principal use of seaweed is for manuring land. Under the name of carrageen, or Irish moss, some is used for food. In France, a gelatine or gum is prepared from seaweed, which is variously useful in the arts, as in finishing cotton fabrics, making artificial leather, etc. When chemically prepared and pressed, it was, at one time, used extensively for the manufacture of a substitute for horn, called laminite, but this has been dropped. It has occasionally been made into paper.

There is an application of waste substances of vegetable origin that is largely carried on, which certainly does not merit approval, being, for the most part, prosecuted for the purposes of deception and fraudulent gain, and this is in substitutes for, or additions to, coffee. Figs, date stones, lupines, malt, chicory, etc., are largely sold, besides the seeds of a stinking weed (*Cassia occidentalis*) which, when roasted, according to French authorities, is equal to coffee. While the production of coffee is fully equal to the demand, and the price is moderate, I cannot see the necessity for these various substitutes. The more legitimate use of date stones is that to which they are put by the Arabs. They are soaked in water for two or three days, and when somewhat softened, used to feed their camels, cows, and sheep. There are shops in Medina where they sell only date stones, and the poor often occupy themselves in collecting the date stones thrown about the streets by those who eat dates.

Ineffectual attempts have been made, from time to time, to utilize the coffee leaf for a dietetic beverage, but the coffee leaf disease and the injury to the trees have effectually checked this. The subject was much discussed a few years ago in the *Journal*. So on the coffee plantations in Brazil and India, endeavors have been made to distill a spirit from the pulp which surrounds the coffee seed. Coffee grounds are, I believe, extensively collected in France, and revivified and flavored for usage again; but latterly the agriculturists of France have sought to employ them (M. Payen asserting their great value) for manure. As the consumption of coffee in France is stated to be about 50,000 tons, it is asserted that large quantities of this *marc* might be obtained from the hospitals, barracks, coffee houses, etc.

Cocoa is not so largely consumed in this country as on the Continent. But the cocoa shells or husks, which are separated from the nibs after sifting, are imported here to the extent often of 500 tons annually, paying a duty of 2s. a cwt., against 9s. 4d. a cwt. charged on cocoa and chocolate. These shells or husks form about 12 per cent. of the weight of the beans. In the manufacture of the finer chocolates this is always separated, and hence accumulates in large quantities in France and Spain. In the cheaper kinds of chocolate and cocoa, these husks are ground with the nibs, and some other cheap farinaceous substance is added. The black appearance of such chocolate is unmistakable; it will always be found gritty and rough, and, of course, difficult of digestion. The husks are no better than sawdust, and may cause irritation by the minute spiculæ left after grinding.

[*To be continued.*]

THE COMMERCIAL MUSEUM OF BRUSSELS.

CONSUL WILSON, in his last report, states that the Belgium Government has just opened, in Brussels, a commercial museum, under the control of the Minister of Foreign Affairs. The declared intention of the government, in creating this museum, is the exhibition of specimens of both raw materials and manufactures of all countries. In arranging the samples, a portion of the building is devoted to each category of products from all countries, and these are so classified that a visitor can at once see, not only the origin of each specimen, but, with the aid of a catalogue gratuitously furnished, may also study its industrial value or adaptability to the markets he desires to reach. In addition to the information supplied in the catalogue, there is a *bureau d'information* for the purpose of answering all inquiries, and explaining such addditional facts as the Government may possess relating to the origin, character, and practical purposes of each sample, with the cost of its production, and all other items relating to its commercial value. Another of the functions of this bureau is to procure, for the information of all concerned, plans and specifications of all proposed improvements, either foreign or domestic, that may be yet open to a competition for contract, with a list of the awards of such contracts as have already been made, including the terms and conditions of the same. Desks, tables, and writing materials are also provided for the convenience of visitors who may wish to avail themselves of them in taking note of any of the contents of the sample department. There is also attached to the museum a library, composed of technical works on the principal industries of the world, dictionaries of technology, catalogues of museums of art and manufacture, foreign journals of manufacture and commerce, and especially such as contain notices of proposed contracts for all kinds of material and labor products. Another department, called the *indicateur*, contains the special archives of the museum. No outside correspondence is permitted directly with this bureau, and all communications intended for it must be first inscribed at the Ministry of Foreign Affairs, after which they are sent to the museum by the chief clerk of the Department of Commerce and Consulates. Documents issuing from this bureau must be signed and submitted for the approbation of the chief secretary of the Department of State, and then forwarded to the Minister of Foreign Affairs for his approval. All documents furnishing information as to the articles on exhibition in the museum are regularly filed and numbered with a special number, so that, by consulting the catalogue and the number of the document, any article may at once be found. A weekly journal is published in connection with the museum, devoted to practical information on all branches of industry and commerce, generally gleaned from foreign sources by the consuls and other foreign agents of the government. The public is admitted without fee every day except Sunday, from half-past nine in the morning till four in the afternoon, and any person wishing for special information, not obtainable from the samples, by signifying to the doorkeeper his desire to consult the *bureau d'information*, is at once admitted, and the information readily supplied. It is intended so to extend the sample department as to embrace not only specimens of foreign manufactures, but every kind of foreign crude or raw material capable of being converted into manufactured products by the industrial establishments of Belgium. There is also in this building a very important department called the "package and finishing room." Under the impression that the manner in which merchandise is packed, labeled, and otherwise prepared for the market has much to do with its recommendation, the government have devoted these rooms to the study of this art in all its details. It is intended here to exhibit the finest specimens of packing, and the most attractively prepared merchandise, both foreign and domestic. In announcing the object of the museum, the government claim that, as a producing country, Belgium has nothing to fear from the competition of any foreign country, either as to the quality of her manufactures or the price of her soil products, but declares that, in order to secure her legitimate degree of commercial success in distant foreign countries, two things are absolutely necessary. The first is to free herself of her dependence upon the other great commercial States that surround her, and sell her merchandise in foreign markets as their own, thus depriving her manufacturers of the profits of direct sales to the consumers; and the second is better to conform the manufacture of her merchandise to the taste and wants of foreign markets. It has given orders to all its consuls and other foreign agents to collect from every part of the world where they may be located, samples of such manufactures as are most in use there, to ascertain the styles and patterns most esteemed, and to send them home to this museum. These officers are especially enjoined to send home specimens of metallic ores, textile fabrics, and all such raw material as may in any way be capable of being converted into useful products, that the genius of the Belgian manufacturers may be stimulated to a more diversified production.—*Journal of the Society of Arts.*

LAUNCH OF A CHANNEL STEAMER.

THE iron twin screw steamer, C. W. Eborall, which has been built by Earle's Shipbuilding and Engineering Company, Limited, of Hull, for the South-Eastern Railway Company's passenger and cargo service between Folkestone and Boulogne, was lately launched. This boat, which is a sister vessel to the S.S. Folkestone and Boulogne, which also were built by Earle's Company, is a handsomely modeled fore and aft schooner rigged steamer, measuring 190 feet b. p., 25 feet beam, and 12 feet depth of hold. Her gross tonnage is about 410 tons, and she has been constructed under special survey to class "A 1 Channel Service," in Lloyd's Register. Her engines are 110 nominal horse power collectively, each engine having two cylinders 20 inches and 39 inches in diameter by 24 inches stroke. This is one of five steamers Earle's Company have in hand for English railway companies, as they are building two large steamers for the Manchester, Sheffield, and Lincolnshire Railway Company's Hamburg and Rotterdam trade, and two large fast steamers for the Great Eastern Railway Company's service between Harwich and Antwerp.

ENGLISH AND AMERICAN LOCOMOTIVES.

A RECENT number of the London *Engineer* contains some editorial remarks on American locomotives, in which special reference is made to the new engine of the Central Pacific road built for service on heavy grades. The writer asserts that two English engines with 18 × 24 cylinders would be superior to the engine of the Central Pacific. Mr. Stevens, the General Master Mechanic of the road, found upon trial of this engine that it was equal to two of his 18 × 24 link engines. Now it is quite obvious that if this new engine is equal to two 18 × 24 American engines, it is certainly superior to two 18 × 24 English engines, and especially in view of the fact, of which there can be no question, that the American type of engines has always proved superior to the English type on the same track. The *Engineer's* preference of two engines to do the work of one tallies very well with the absence of bell-cords and other modern conveniences and safeguards in the running of English passenger trains. No manager of an American road would be so foolish as to incur the expense of repairs, fuel, and crew for two engines, when such expense could be reduced one-half by using only one; and as for an engine at each end of a train, as the writer suggests, there are but few train men on our roads that would care to take the chances of piling up the cars by such an arrangement, in case of accident, when the practice, so common on our roads, of "double-heading" trains is equally effective and much safer.

As respects valve gear, the writer seems quite content with the English system, although Mr. David Joy says that the American link motion is much more "refined;" and as for the Joy gear, which has been trumpeted a good deal during the past year or two as a great improvement, Mr. Reuben Wells, the President of the Master Mechanics' Association, demonstrated before that body that there was no difference in results between it and the American link motion. A locomotive with this gear will require, at the most economical point of cut-off, an actual consumption of from 31 to 32 pounds of water per horse power per hour. The *Engineer* has claimed heretofore that English engines used only 18 pounds, but this was the theoretical and not the actual consumption. Any of our high speed automatic cut-off stationary engines, all of which use the riding cut-off valve, in principle, at least,

will develop a horse-power on an actual consumption of from 21 to 25 pounds of water per hour. The valve seats and valves of a link motion locomotive require to be faced every six to eighteen months. There have been riding valve engines on our roads, that were almost identical with that of Mr. Stevens' engine, that did not require any work on valves or valve gearing in from three to five years, and this was due to the constant travel of the valves, there being no wire-drawing openings as with the link. These engines made an average mileage of 800 miles per week, and hauled trains of 700 and 800 tons. If the *Engineer* does not consider the use of 22 instead of 30 pounds of water per hour, and a valve gear that lasts two or three times as long as the link, as a step in the right direction—which Mr. Stevens' new engine certainly is—it must be owing to an inveterate and unreasoning attachment to old time systems and methods merely because they *are* old.—*Nat. Car Builder.*

THE SCREW PROPELLER.*

By ADOLPH COUNT BUONACCORSI PISTOJA.

THE word "propeller," from the Latin "propellere," to push forward, means that kind of instrument by which a body properly connected with it is pushed forward. The word "propeller" is used almost exclusively for that class of instruments by which vessels are moved. Of the several methods of propulsion, the principal are: The sail, the paddle wheel, and the screw.

There is no doubt that the screw was known to the ancients, but the assertion that its first appliance for navigation purposes was made by our ingenious Ressel is to-day controverted; the French and the English both laying claim to the honor of this invention. It is stated in France that Daniel Bernouille, in 1752, and after him Dallery, in 1803, proposed the screw as a propeller for ships.

It is certain that the first patent for screw propellers was granted to Frederic Sauvage in 1832, that is, at the time when our own Ressel, using a screw on a steamer, the Civetta, had been sailing at Trieste for a long time from August 5, 1829.

Josef Ressel had already taken out a patent as early as 1812 for the first and a primitive form of a ship screw (Fig. 1); at the same time he made the first experiments by hand with it.

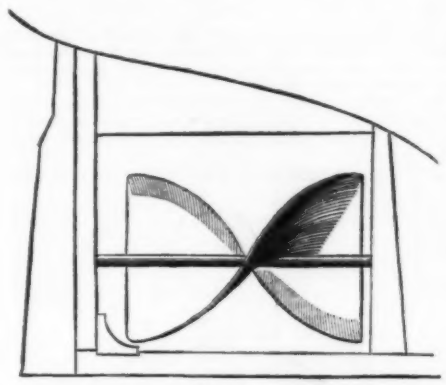


FIG. 1.

The English allege that Ericsson and Smith, both Englishmen, were the inventors of the propeller. The truth is that only the first improvement of Ressel's invention was made by Smith. (Fig. 2.) Smith made a trial trip with his propeller on the Thames, when the screw, which was double grooved, struck the chain of one of the many ships anchored at the river's mouth in the channel, breaking the backward blade clean off. By this lucky accident the motion of the vessel was suddenly accelerated, a fact which was not lost upon Smith.

Whoever may have perused the unostentatious and convincing data, and authentic proofs, presented by the captain of the frigate Littrow, a contemporary of Ressel, or the memoir, abounding with noble and patriotic ardor, of Dr. Edmund Reitlinger, will no longer doubt that Ressel is the only and true inventor of the screw propeller.

FIG. 2.

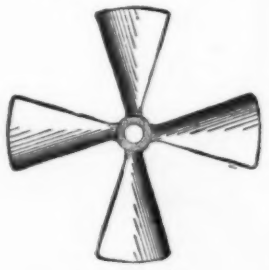


FIG. 3.

Consequently, the duty remains for us to honor the name of Ressel by at least helping to establish his unassailable and exclusive rights to this invention, the more so as in foreign books and writings the name of Ressel is not even mentioned at all.

It is a fact that the screw propeller had, like every other invention, its development; so that to-day we may count a surprising number of ship screw systems, some 150 in all, which are all different in principle. Of these only about half a dozen have been retained in use; and it must be noticed that the original Ressel screw, repeatedly improved with plain warped wings (Fig. 3), is to-day the screw mostly adopted.

Generally, the ship screw, with which we are dealing exclusively is a propeller whose action is similar to a screw placed parallel with the ship's keel, its head being attached to a given point at the back part of the vessel, moving in the water as in the box of a screw. According to the motion originating in the interior of the vessel, the vessel itself, which is fixed to the screw, will evidently be pushed forward or backward. This explanation does not, however, give us the exact idea of the action and effect of the propeller. If the ship's screw should really be equal to the aforesaid screw, it ought to be ideal; that is, have no nave, and we must suppose the water frozen solid, in order to take the place of the solid female screw.

Screw propellers may generally be classified into two kinds, viz.: screws whose blades, though varying, always show the plain warped surface; and those whose blade surfaces are bent and curved in various manners. The former class we call screws with straight thread or constant pitch; the latter screws with broken leading lines, or screws with increasing or variable pitch.

A screw with constant pitch (Fig. 4) is that in which the generating line of every blade, sliding along the boss, always keeps the same angle with the latter, for the various elements of the leading line belong to the same screw, respectively screw line; or in other words these elements are parts of a screw of constantly equal pitch. In order to understand the working of such a screw of the first kind with flat warped blades, or with equal pitch, we have only need to observe the part, *a f g c*, of one of its spirals in action: suppose this part to be attached to the end of a shaft, H M (Fig. 4), which

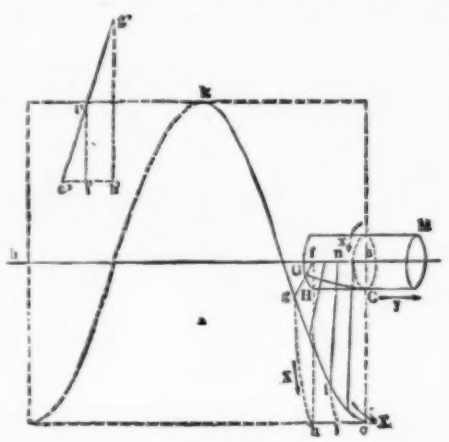


FIG. 4.

is fixed to the stern part of a vessel, parallel to the keel, in such a manner as to allow to said spiral only a rotary motion. In this case the plane, C G *g c*, supposing it revolving in the direction of the arrows, *x*, will evidently receive a pressure from the water, inclined to the axis, *a b*. We can divide this pressure into its two components, the one vertical and the other parallel to the axis, *a b*.

The component vertical to the axis will only result in the effort to force the back part of the vessel in a direction which is declining from that of the screw. But the other components will always act in the direction of the arrow, Y, parallel to *a b*, with the effect of exerting itself on the vessel to compel a forward motion. In the case of contrary rotations the effect will evidently be the contrary, and so the course of the ship will be contrary.

It can easily be understood, that in this construction of the screw, the labor resulting from the effect of the first vertical component is totally lost. Every per cent. which we gain from this component by a corresponding change in the construction, so as to induce it to act in a direction ever so little nearer to that of the axis, will, after all, mean a direct increase in the effective work of the screw propeller. This possibility has been the cause of the various attempts at improvement made in screw propellers, and accounts for the surprising number of screws, all differing in principle, that we find.

But whoever has constructed a screw propeller knows how sensitive such an instrument is. A little pitch, more or less, can eventually very much increase the effect, while a scarcely appreciable change made at the wrong place will entirely annul that effect.

Two screws of my system (Fig. 5), of seemingly almost

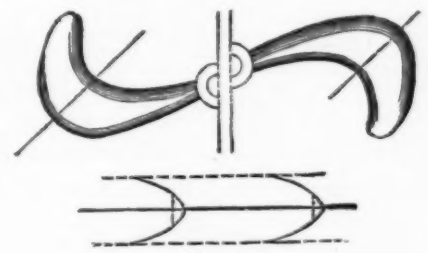


FIG. 5.

equal appearance, but whose normal sections, taken vertically and parallel to the axis, differ in the respect that the parameter of the generating parabola of one of these screws is imperceptibly smaller than the parameter of the generating parabola of the normal screw, give most conclusive evidence of this difference in effect. If set in rotary motion, the one shows the normal movement, while the other does not move from the spot at all.

Turning to the second kind of screw propeller, we wish to remind our readers that it was a result of the first form, the constructors endeavoring to increase the useful effect and diminish the loss of work—creating an instrument to act upon the fluid element the most effectively and favorably and prolong that action as long as the fluid remained inside the blades. From such experiments there resulted *screws with increasing or variable pitch* or *screws with broken and curved leading line*. Before beginning to speak of these latter forms of propeller, we have briefly to show the principal defects of the plain screw with warped blades, in order to comprehend the changes which the principal inventors aimed at especially, or in other words, what gain was made in the changes, which, however, were often the result of chance.

We have already spoken of the loss by one of the working components resulting from the innate qualities of the warped planes. Another very considerable loss is due to the rotary motion of the screw, from the slinging effect which takes place at the time, and which forces the water away radially. In both cases a part of the water is thrown away outside. An observation of the keel water of such a screw will show us the fluid being shaped like a shortened cone, whose smaller case is near the vessel and the lines bounding this cone diverge from the observer, or from the vessel's stern. These two efforts, which decrease the useful work of the screw, are denoted by the one term, centrifugal force of the screw, as both manifest themselves in one phenomenon.

The second factor of loss in the useful work of the screw propeller, in its exclusively marine application, is that which results from the friction of bodies in general. The larger the surface of the screw (limited by the thicknesses of boss and blade, the length, width, and number of blades), the greater will be the friction with the water, and consequently the greater the loss of effect.

Finally, another factor which adds considerably to the loss of useful work in the screw propeller, as of all other propellers, is "slip." This results from the variability of the fulcrum, in this case the fluid element, and causes the necessity of disproportionately increasing the rotary movement of the screw in order to make up for lost action.

Having noted the principal causes of loss of work, we have yet to mention: 1. That the fluid on account of its adhesion shows a reluctance to leave the blades, and consequently there is an amount of dead water always between the blades, which must be carried round. 2. The water which is put in action by the blades receives shocks which react upon the blades themselves, in case the water is pushed too violently. 3. That the screw, in order to effect the onward motion of the ship, has permanently to throw back a certain quantity of water, which is taken from the keel water at the sternpost, resulting in a loss of static pressure at this point, in the same degree increasing the resistance at another point. These different observations explain that the useful work of such screws, measured however accurately, gives a result of only some 50 to 60 per cent.

The first idea of screws with broken leading line (Fig. 6)

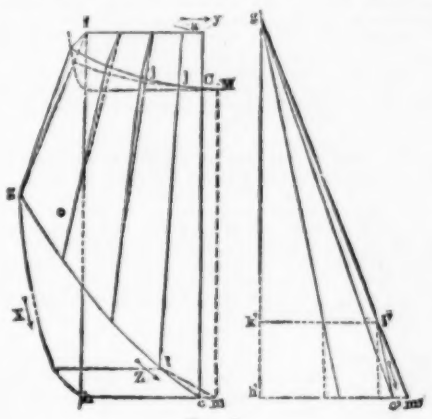


FIG. 6.

we find in the letters patent of an Englishman, Woodcroft, in 1832.

We shall examine the part, *a f g c*, of one spiral. In the screw the generating line, *a e*, makes with the boss angles, which, instead of being equal for equal distances along the boss, increase, while the line, *c i g*, advances. This increase may occur at certain points either suddenly or by degrees. From this there results that the leading line, *c i g*, ceases to be part, *m i g*, of a screw, but consists of several sections, *c i*, *g i* all having different pitches, which grow greater from the front to the rear.

If we stretch out *g' i' c'* into a plane, we have the rectangular triangle, *g' h' e'*, whose hypothenuse, *g' i' c'*, is no longer a straight line, but, according to the rotation of the generating line, *a e*, a broken or curved line.

Of the two generating lines, *a e* and *f g*, the first is called the "entering edge," for by it the screw, rotatively advancing, as shown by the arrows, *x y z*, acts upon every new layer of water. The other, *f g*, is called the "leaving edge."

The advantage of this disposition is immediately understood: 1. The fluid is acted upon without shock, and is prevented from trying to escape backward. 2. The water filaments striking the blades at too much inclination find time to extend themselves, and to slide along the effective surface. From this it results that if the succeeding portion of the blade tends to put the fluid in motion, it meets with water already moving, and having a greater pitch than the first part of the blade, it receives from this water more resistance than the common screw. This system also causes a decrease of shock against the water when in action and with the same pressure a decrease of slip.

It is to be noticed that screws were sometimes used in which the generating line and not the leading line is a curve. Such a screw as this was that of Hodgson (Fig. 7), proposed

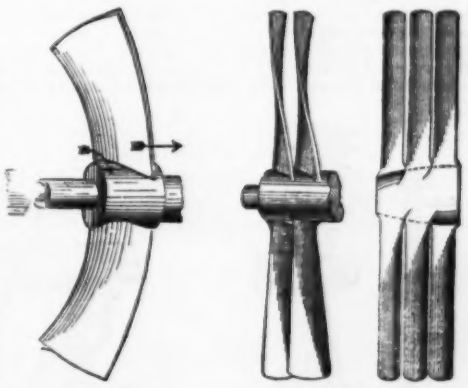


FIG. 7.

FIG. 8.

in 1844. It consisted of two equally concave blades. Hodgson gave to his generating line the form of a parabola, to compel the water filaments to draw together in the direction of the foci of the parabolas, and to press convergently to the axis in order to decrease the centrifugal effect of the screw.

* A paper read before the Austrian Society of Engineers and Architects at Vienna.—*American Engineer.*

Though generally all screw propellers of older date belong to one or the other of the above systems, attempts at improvement were made in other directions, which we must not omit here, in order to give a complete survey of the subject. At first came the doubling and multiplication of the blades, one behind the other. Screws with these modifications, Fig. 8, were for the first time proposed by the marine engineer Meingin. The aim of these changes was that by adopting smaller blades it was easier to remove the screws when necessary, as in the case of auxiliary screw ships, when the sails would be used when advantageous.

Another arrangement of the screw, invented by the naval architect Sollier, aimed at keeping the propeller as highly effective as possible during steaming without its being a great obstacle while the vessel was under sail. For this purpose the four blades of the screw were arranged in such a way as to make it possible to fold two and two together like scissors while under sail, and, on the contrary, when under steam, they were used normally. In this way the screw only offered a resistance equal to two blades while sailing, but could be made equivalent to a four bladed screw when steaming.

We have now to mention a combination screw—a double screw with crossed blades. This was a very old invention, for Fortanini used it for aeronautic purposes. In this instance two common two bladed screws were placed, one behind or underneath the other, in such a manner that each screw revolved in opposite directions. But as this arrangement could only be executed by putting on the shaft to which the first screw was attached a movable nave for the second screw, it can readily be seen how unsafe and complicated a construction of this kind must appear in practice. These inconveniences did not crush the idea; on the contrary, in the last case, further attempts were made in a similar direction, by proposing to let the screws revolve, not one behind the other, but one through the other—the space for the passage of one screw to be taken out of the other. The idea in this arrangement was, as the inventor thought, that when the water was put in motion in one direction by the first screw, the second screw, which was to revolve in a contrary direction, would encounter a greater resistance from the water thereby. But it can be readily seen that the insignificant increase in effect would be quite out of proportion to the necessary double, and still greater expense of work, as well as to complications in construction.

Another improvement in the effective work of the screw, which has maintained itself in practice to the present day, although one of secondary value, was made by inclining the blades to the axis instead of fixing them rectangularly to it. By this change the keel water strikes the screw under more favorable conditions, as it is not acted upon at once, but by degrees, thus allowing the water threads to extend themselves. Hereby a counterbalance is created to the centrifugal effect, while the fluid particles are pressing convergently to the axis. The first man who proposed such a screw was Lord Dundonald (Fig. 9).

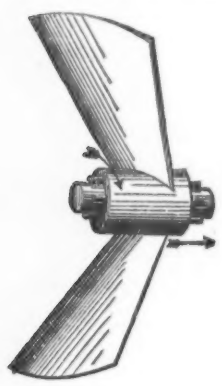


FIG. 9.

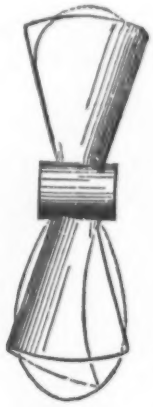


FIG. 10.

It is singular that the first instances of this modification gave a declination of screw *from* the ship, and it is only in later times that the blades have been inclined *to* the vessel. The angle of this inclination varies, and is not yet fixed by rule.

We would further mention that the blades of both kinds of screws, that is, screws with straight as well as curved leading or generating lines, were cropped and rounded, Fig. 10, because the inventors were, by this method, in hopes of avoiding all parts which decreased the effect; but this manipulation reminds us of the old proverb, which is just as good for screw propellers: "What we cannot get out by bushels, we cannot get out by spoons."

There exists, besides the original types of screws described, those with straight and curved leading and generating lines—screws wherein the fundamental principles of the two systems, which, however, on account of peculiar construction, cannot, or only with difficulty, be discerned: screws of quite exceptional qualities, so that we might call them "exotic" screws, and we must now examine the principal examples.

Lieutenant Vergne's screw, Fig. 11, has two blades, which

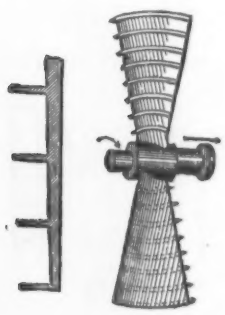


FIG. 11.

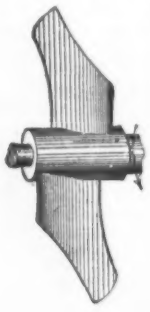


FIG. 12.

are provided at intervals from the boss with fillets or bands. The bands project 0·15 mm. to 0·18 mm. and have a width of 0·4 mm. Their intention is to diminish the centrifugal force as well as the vibration caused at the stern of the ship. Vergne's screw is said to have proved very satisfactory when applied to some vessels, while in others the effect was mediocre. It can easily be understood that while the bands might decrease the centrifugal effect, the friction of the blades in the water would be increased, and so any advantage gained would be annulled.

Another inventor, Holm, tried to decrease the centrifugal action by making the blades spoonlike.

The boomerang screw, Fig. 12, was proposed in 1848 by an English captain, Mitchell. In principle this screw had the form of the boomerang, a weapon used by the natives of Australia, from which the name was derived. But from its unsubstantial shape, requiring also too large a sternpost, the screw was changed to the above pattern, which is by no means similar to a boomerang, but which differs from the usual screw by the position of the blades, which are set to an angle of 180° in order to act more favorably upon the water. No prominent advantages being observed, and on account of the increased size of sternpost, this screw had only an ephemeral existence, and I have only mentioned it here in order to show the different forms of screw advocated.

Ericsson's screw, Fig. 13, consists of several, but shorter

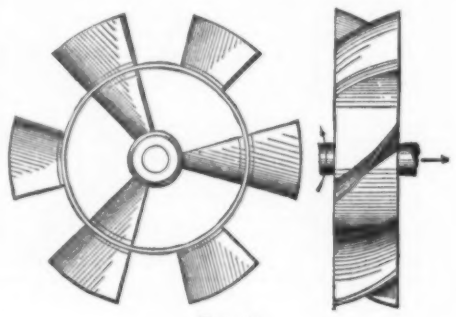


FIG. 13.

blades than the common screw, fixed at a certain distance from the boss upon a metal ring. The ring itself is firmly connected with the boss through the three principal blades. Here we have a screw which is *in optima forma*, and since its invention it has been much used both in France and America.

Maudslay's screw, Fig. 14, constructed by the English engineer in 1848, is arranged so that the blades can turn upon their own axes, and are masked, while sailing, behind the sternpost, by which arrangement so much obstruction to

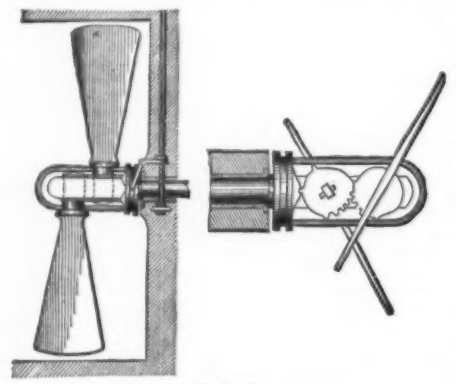


FIG. 14.

sailing was removed. But the mechanism being so complicated, the possibility of getting out of order was pronounced. Very many ruptures were the natural consequences of so complicated a construction.

We see from the foregoing that the various kinds of construction were adopted to secure increased effect. Among all these, sometimes quite arbitrary attempts at improvement, only two of the changes in the construction of the screw can be regarded as especially useful. They are: 1. The curvature of the leading line; and 2. The curvature of the generating line. Screws in which both the leading and generating lines are curved are now mostly used in modern navigation, and we will examine some of the types of this form.

The first patent for such a screw, Fig. 15, was taken out

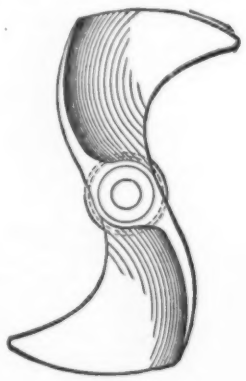


FIG. 15.

by the English engineer Hirsch, in 1860. The generating line is the segment of an Archimedes spiral, while the leading line is constructed after the manner previously described. A characteristic arrangement in this screw is that the ends of the blades are in action before the blade itself. All other changes in screws made since this are changes either in the manner or angles of inclination of the blades, or changes with respect to croppings or distortions of the blades, and in other peculiarities. But the curves which the leading and generating lines present are different in every kind of screw.

It is evident that for a certain case there can be only one curve answering to the demands of greatest effect, and the principal aim of the inventor has always been to find the best curve for the greatest effect. Of course, the *whole conception* of the screw had to be well considered in order to promote a striking success. All screws which did not answer to the consideration of effect, though they were all right with regard to their fundamental principles in the design of leading and generating lines, could not maintain themselves in practice.

We must now speak about the systems of screw propellers most in use at the present time, previously referring, however, to a certain type of screw, which, though not maintaining a position for long on account of not generally answering to the proper conception, still shows the most profitable curve for effect—the parabola. This form was invented by an Austrian, Major Kadaiz, Fig. 16, but as in Nos. 14 and 15

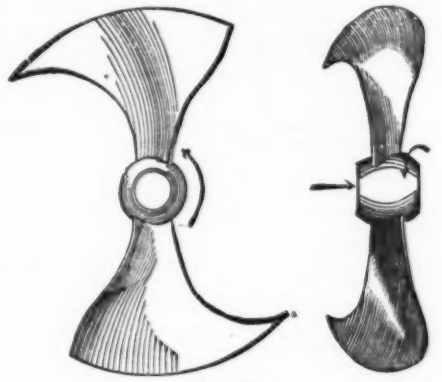


FIG. 16.

of the 24th annual volume of the *Journal of the Austrian Society of Engineers and Architects* will be found an excellent and correct article on this propeller by M. Kadaiz, it is unnecessary to say more.

The types of screws most in use at the present time are, except the improved Ressel screw with plain warped blades (see Fig. 3, *ante*), those invented by Griffith, Jarrow, and Thornycroft.

It is a special peculiarity of the Griffith propeller, Fig. 17,

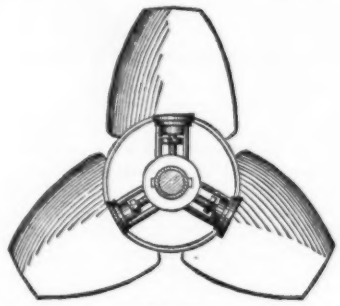


FIG. 17.

that the blades can be turned on their axes, so that it is possible to give them more or less inclination, according to the speed intended for the ship.

The Jarrow propeller, Fig. 18, is a two or three bladed screw with strikingly long blades, whose ends have a pe-

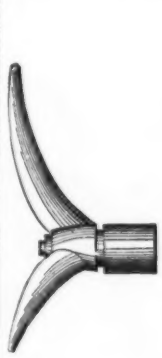


FIG. 18.

FIG. 19.

culiar point. This propeller is very much used in England and America.

Thornycroft, Fig. 19, tries to obtain exceptionally great rapidity for the ship by inclining the blades considerably backward, thereby giving them the form of long lever arms. The Thornycroft propeller is used for fast ships, torpedo boats, and torpedoes.

It seems to be settled by the various kinds of screw construction that curves of the parabolic form apparently give the greatest effect in the propellers. We can see it also in an example of swimming apparatus presented by nature herself, in the form of the fish, for just at the most vigorous and effective strokes of the tail, when it is moving quick as lightning from the spot, that member always forms a parabolic curve; it is the same with large fish as with small. At the same time, we observe that the tail of the fish always bends in curves and never in angles.

I wish now to describe the screw propeller invented by myself; that is, I shall show its most prominent principles of construction as far as the necessary limitation of publication of a privileged subject allows.

We have already mentioned that the perceptible increased effect of one or the other type of screw propeller does not rest so much on a certain peculiarity, but rather on the whole conception of a screw. There are, of course, many variations possible, but it must be kept in mind that for possibly the most favorable effect only one most appropriate construction and conception can be entertained. We have said that almost all methods of screw construction have shown that a parabolic curve for the screw was the most favorable and effective in action upon the water. We also said that a certain inclination of the blades toward the axis was favorable to the reception of the water, and to the work of the different particles of water upon the blades. We spoke at length in the opening of this article to the effect that the water under the action of the concoidal propeller shapes itself into a cone, destroying in a large manner the effect of the propeller, as it means scattering, or loss of work.

In constructing my screw I tried to avoid these disadvantages and to make use of the proved advantages.

Both the generating line and the leaving line are, in the Buonaccorsi propeller (Fig. 20), parabolas of exactly determined form; the parameters according to the size and purpose of the screw, while at the same time the pitch and the parameter are in a certain proportion to each other, in order to compensate each other. The blades are inclined toward the axis, to allow the water to enter most favorably. The thickness of blade and boss, from the solid, safe, and ductile material used, is reduced to the minimum, to save loss by friction with the water, and lastly the water is shaped by the action of this propeller into a cone, but with the difference that its base is toward the sternpost, while the side lines diminish in the wake instead of spread. From this result the water particles press convergently on the axis, being caused by the other special peculiarity of this screw, the water filaments meeting in the foci of the parabola.

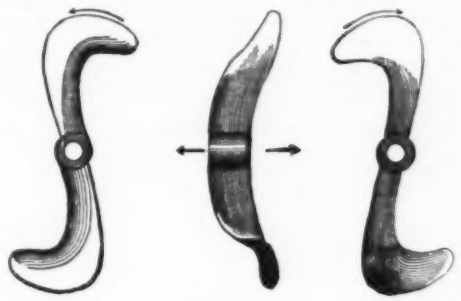


FIG. 20.

It is a fact proved in practice, and published in the Proceedings of the Austrian Society of Engineers and Architects, No. 35, September 3, 1881, that this screw requires a much smaller expenditure of power, and that its scattering cone is much smaller. We can prove these advantages by the following experiment:

Fig. 21 shows a small hand machine with a revolving vertical spindle. On this spindle models of screws, of exactly equal weight and diameter, are set in rapid revolution, one after the other. The power is obtained by weights, and we observe that the Buonaccorsi screw is put in upward motion by only half the weight necessary to raise the normal screw with warped blades.

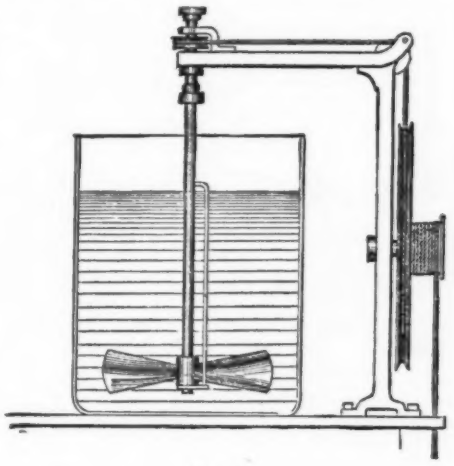


FIG. 21.

In the arrangement of the comparative tests with the weights, the spindle was placed vertically, because the effect of the screws, stationary and rising and falling, could be better observed in that way. We can show the useful effect of the different types of screws by increasing or diminishing the weight necessary to produce rotation, and determine it to a gramme.

In order to examine the screws as to the scattering cone, the same apparatus is used and similar operations performed, only, to avoid minuteness, they are revolved by hand.

Before starting the experiment some amber dust, which has only a small specific gravity, is put into the water. The dark amber, on account of its lightness, is moved with the water particles, and we get a good illustration. Fig. 22, of the direction of the motion, and shall see that my screw has not only a much smaller scattering cone, but that the bead of it appears declined from the screw, while with screws of the other systems the contrary is the case.

In order to examine various kinds of screws in their natural way, horizontally, as in place in a vessel, with regard to their effect, and in order to exclude any chance of delusion, the same apparatus provides for this experiment too, as seen in Fig. 23. The horizontal arm is turned up into a vertical position and a cord roller attached; the spindle is placed horizontally in the water, and at its end carries another cord roller: power and motion are thus transmitted to the models. The spindle is secured to hangers, one of which is fixed to the table and the other to the revolving apparatus.

The spindle receives at each end one of the models on trial, and to prevent the screws running together in the center of the spindle a piece of loose pipe is placed. The spindle being put in motion, it is evident that the better screw will advance the quicker: arriving at the pipe, the pipe will be driven along the spindle until the other more slowly advancing screw is met; at last this opposing screw will even be repelled, although it has not got the same rapidity of revolution and the same motive power.

We have here, in a word, the most direct comparative trial.

It now remains to mention the boss of the propeller, upon which many attempts at improvement have been made, and also the materials from which ships' screws are made.

For a long time constructors were of opinion that the boss had a disproportionate centrifugal or slinging action, supposing that herein lay the seat of this radical defect; so in efforts to improve its construction it has been given all kinds

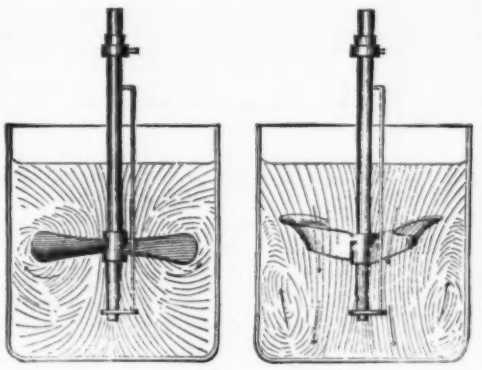


FIG 22.

of spheriodal shapes, until at last the form of a ball was reached, to which yet quite a little centrifugal effect is generally ascribed. Attempts were made to remedy the breaking of the blades by screwing them into the boss, and by building the boss of as many parts as there were blades, and screwing them together to facilitate the changing of blades. Improvers in this direction were not troubled with the fact that the screw was weakened and the weight of boss and blades increased, making the screw heavier and incorrect.

The qualities of the material from which a screw is made are of course important to its success, although not much in a badly constructed propeller. We have to consider that the weight of the screw can have a great influence on the very sensitive sternpost, and it can be readily seen that if a screw must have great thickness in boss and blades on account of brittle or unreliable material, the useful effect of the screw is diminished by the extra friction produced.

It is therefore necessary to use most solid material for the screw to limit the thickness of its parts, and consequently its weight.

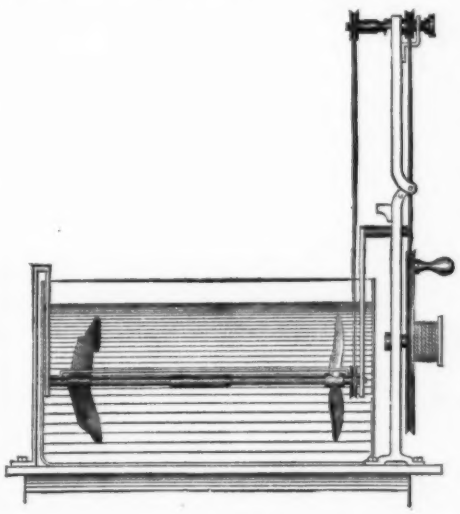


FIG. 23.

The ideal material for screws would be forged steel but the considerations of working out difficult curves, the power of resisting the decomposing action of sea water, and cost of production, render forging secondary to casting.

A coat of zinc or enamel has smoothness and a slippery soap like character, and would surely be a good means to diminish friction and improve the effect of ships' screws.

ON THE LIMITING NUMBERS OF TEETH FOR SPUR WHEELS.

By Prof. C. W. MACCORD, D.S.

II.—*Involute Teeth.*

IN a previous article (SUPPLEMENT, No. 306), an explanation was given of a new method of determining the least number of teeth which can be assigned to a wheel, when the diameter, pitch, and arc of recess of the one which is to engage with it, either in the capacity of driver or of follower, are given.

The teeth discussed in the article referred to were of the epicycloidal form, which is probably more extensively used than any other. The chief rival to the epicycloid in the favor of mechanicians is the involute, which possesses advantages peculiar to itself, and is by many preferred for various purposes. The discussion of the question of limiting numbers, therefore, would be far from complete without giving due consideration to wheels having involute teeth. This has not, up to the present time, been done: which is the more singular, because one is more liable to assume incompatible or impracticable conditions in laying out these teeth than in dealing with the epicycloidal system. Again, there is a marked contrast between the two forms of gearing, not only in the mode of generating the tooth-outlines, but in the peculiarities of the action; so that a special interest attaches to a comparison of the limiting numbers in these leading systems.

We shall therefore proceed to investigate a method of ascertaining these limits, under the same conditions that were assumed in treating of the epicycloidal form, viz.:

$$\text{Tooth=Space.}\begin{cases}1.\ \text{Recess=Pitch.}\\ 2.\ \text{Recess=}\tfrac{3}{4}\ \text{Pitch.}\\ 3.\ \text{Recess=}\tfrac{2}{3}\ \text{Pitch.}\end{cases}$$

In Fig. 1, next page, let C D be the centers of two wheels, V W and X Y arcs of the pitch circles tangent at A, F Q the line of action, C Q and D F the radii of the base circles; and suppose the lower wheel to drive in the direction shown by the arrow.

The proportions are so chosen, that the tooth of the driver is pointed, and that its point Q extends just to the root of the other involute. Also, the breadth M N of the tooth being equal to the space N L, both measured on the pitch circle, there is no backlash.

This diagram illustrates an exact limiting case. If the pitch M L and the arc of recess A M be assigned, the involutes bounding the tooth G Q K must pass through the points M and N, whatever the radius of the base circle. Also, the obliquity T A F which causes their intersection Q to fall on the line of action, is clearly the greatest possible; and this as clearly gives the least possible value for A C.

Having then represented the problem as already solved, it remains to deduce the means of effecting the solution in any given case.

Draw Q D, which cuts the lower base circle in O; then the path of contact F Q is equal to the arc F G; and is also the trigonometrical tangent of the arc F O. That is to say, we have as an equation of condition:

$$\text{tan. F O} = \text{arc F G}.$$

The line of centers cuts the lower base circle in B; now draw through L, A, and N the involutes L R, A I, N H, of the lower base circle, and through A draw also the involute A J of the upper base circle.

Then the arc Q J is equal to Q A, the trigonometrical tangent of the angle Q C A; the arc F I is equal to F A, the trigonometrical tangent of the angle F D A; and the angles Q C A, F D A, are equal to each other and to the obliquity J A F.

We shall now have,

$$FG=FR+2RH \quad \ldots\ldots (1.)$$

$$FO=FG+OG$$

$$OG=\tfrac{1}{2}KG$$

$$KH=2BI,\ \therefore\ KG=2BI+HG$$

$$MN=AL,\ \therefore\ HG=RH$$

$$KG=2BI+RH$$

$$OG=BI+\frac{RN}{2}$$

$$FO=FR+2RH-BI-\frac{RH}{2},$$

$$\text{or,}\quad FO=FR+\frac{3RH}{2}-BI \quad \ldots\ldots (2.)$$

$$\text{Also,}\quad FI=FR+RI=FB+BI \quad \ldots\ldots (3.)$$

Now when definite values are assigned for the arc of recess, these equations will be modified as follows:

I. RECESS=PITCH.

In this case we have,

$$\left.\begin{matrix}RI=O,\\ RH=1H,\\ FR=FI\end{matrix}\right\}\ \text{Whence,}$$

$$FG=FI+2IH \quad \ldots\ldots 1.$$

$$FO=FI+\frac{3IH}{2}-BI \quad \ldots\ldots 2.$$

$$FI=FB+BI \quad \ldots\ldots 3.$$

$$\therefore\ FO=FB+\frac{3IH}{2}.$$

And for a pinion driving a rack,

$$\left.\begin{matrix}FR=FI=O,\\ FB=O,\\ FI=O,\end{matrix}\right\}\ \text{Whence,}$$

$$FG=2IH \quad \ldots\ldots 1.$$

$$FO=\frac{3IH}{2} \quad \ldots\ldots 2.$$

$$\therefore\ FO=\tfrac{3}{4}FG.$$

II. RECESS=$\frac{3}{4}$ PITCH.

We now have,

$$RI=\frac{RN}{2},\ \text{or}\ RH=2RI,$$

which gives,

$$FG=FR+4RI \quad \ldots\ldots 1.$$

$$FI=FR+RI \quad \ldots\ldots 3.$$

$$\therefore\ FG=FI+3RI;$$

and

$$FO=FR+3RI-BI \quad \ldots\ldots 2.$$

$$FR+RI=FB+BI \quad \ldots\ldots 3.$$

$$\therefore\ FO=FB+2RI.$$

When the pinion drives a rack,

$$\left.\begin{matrix}FR=O,\\ RI=FI,\end{matrix}\right\}\ \therefore\ \left\{\begin{matrix}FG=4FI,\\ FO=FB+2FI.\end{matrix}\right.$$

III. RECESS=$\frac{2}{3}$ PITCH.

With this value, $RI=\tfrac{2}{3}RH$, or $RH=\dfrac{3RI}{2}$,

whence,

$$FG=FR+3RI \quad \ldots\ldots 1.$$

$$FI=FR+RI \quad \ldots\ldots 3.$$

$$\therefore\ FG=FI+2RI,$$

and

$$FO=FR+\frac{9RI}{4}-BI \quad \ldots\ldots 2.$$

$$FR+RI=FB+BI \quad \ldots\ldots 3.$$

$$\therefore\ FO=FB+\frac{5RI}{4}.$$

And in the case of a pinion driving a rack

$$\left.\begin{matrix}FR=O,\\ RI=FI,\end{matrix}\right\}\ \therefore\ \left\{\begin{matrix}FG=3FI,\\ FO=FB+\dfrac{5FI}{4}.\end{matrix}\right.$$

Now suppose that the pitch and the arc of recess for the driver are assigned. Then the arcs I H and H G are known; and if we assume a value for F I, we can find the corresponding values of B I and F B, which combined with the other will give certain values for F O and F G; and these are finally to be tested, to see whether they will satisfy the equation of condition,

$$\text{tan. F O} = \text{arc F G}.$$

Having in this way at last found the obliquity which under the assumed conditions makes F Q equal in length to the arc F G, we know also the length of F A; whence A C, the minimum radius of the follower, is readily ascertained.

If on the other hand the wheel whose pitch and arc of

recess are assigned be the follower, we then know the values of Q A and the arc Q J, which are equal to each other, and can thence find the angle A C Q, equal to A D F and to the obliquity. We then, knowing the arcs F B, F I, assume a value for R I, and proceed as before to see whether the equation of condition is satisfied.

When the given driver becomes a rack, the least radius for the follower is most readily ascertained by a special construction which is shown in Fig. 2.

This represents also an exact limiting case, the rack tooth being pointed, and the whole path of contact just equal to the pitch arc on the base circle. Thus, the rack driving in the direction of the arrow, a marking point in going from Q to F, generates the right line Q U and the involute Q G, the latter cutting the pitch circle at M. The action, then, begins at Q and ends at F, the root of the involute F S, which latter curve cuts the pitch circle in L.

Since the tooth and space are to be equal, the side X K of the pinion's tooth must bisect the arc M L at N; and it must also be tangent to the side F V of the rack-tooth, at P its intersection with the other line of action P A Z, to which F V is perpendicular.

It will now be seen that while the marking point is moving from Q to A, it generates the curve Q M, the pinion

Now introducing the same definite values as before for the arc of recess, we shall have:

I. RECESS = PITCH.

$$\left.\begin{matrix} AQ = O, \\ FA = FQ, \end{matrix}\right\} \text{whence } AP = \tfrac{1}{3}AF.$$

II. RECESS = ¾ PITCH.

$$\left.\begin{matrix} AQ = \tfrac{1}{3}QF, \\ FA = \tfrac{3}{4}QF, \end{matrix}\right\} \text{whence } AP = \tfrac{1}{5}AF.$$

III. RECESS = ⅔ PITCH.

$$\left.\begin{matrix} AQ = \tfrac{1}{3}QF, \\ FA = \tfrac{2}{3}QF, \end{matrix}\right\} \text{whence } AP = \tfrac{1}{4}AF.$$

In these cases, then, no tentative proceeding is involved in determining the least number of teeth for the pinion, which requires merely the solution of the triangles A P F, A C F.

In Fig. 2, the pinion's tooth has a sensible breadth Q X at the top, and the involutes might therefore have been continued as shown in dotted lines, thus prolonging the approaching action. But the smaller the assigned arcs of recess, the less is A P, and the narrower will be the tooth at the top, when as in the figure the total arc of action is

From these data we may now proceed to solve the problem in the tentative manner before explained, thus:

Taking any convenient value for the radius F C, we first assume the arc F I, and find the corresponding values of F A, of the angle A C F, and of the arc B I. Then solving the triangle A P F, we determine A P, whence F Q is found as in Equation A.

The length of F Q being equal to that of the arc F G, we next find the length of the arc F O as in Equation B, and knowing the radius, ascertain the value of this arc in degrees.

Finally, we apply the test of determining the length of the trigonometrical tangent of this arc, and comparing it with that of F Q as before found. If these two values are equal, the assumed value of F I is correct; but should they prove unequal, a new value must be assumed, and the process repeated until concordant results are obtained.

In this way we find that the pitch, at the limit which gives a pointed tooth to the pinion, corresponds to

No. of Teeth = 4 09
Obliquity = 44° 20′ 45″
Arc of Recess = 55/96 Pitch

} very nearly.

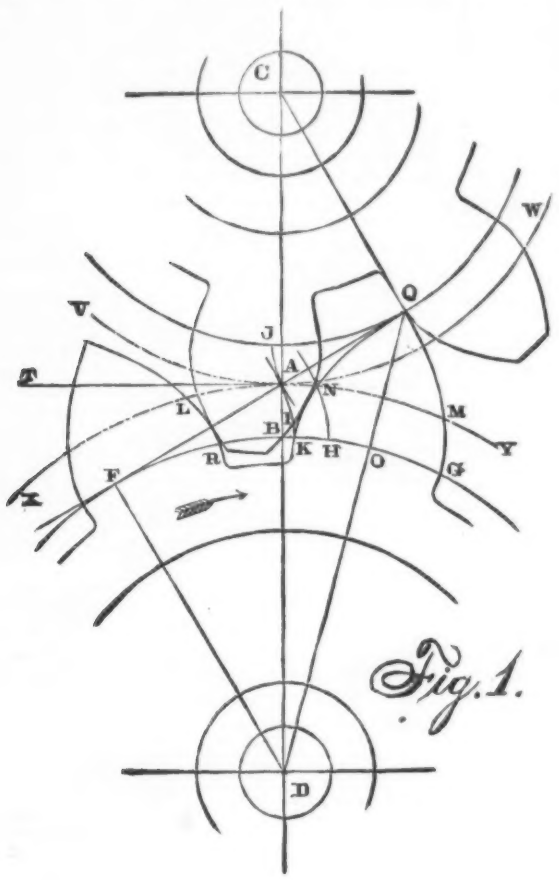


Fig. 1.

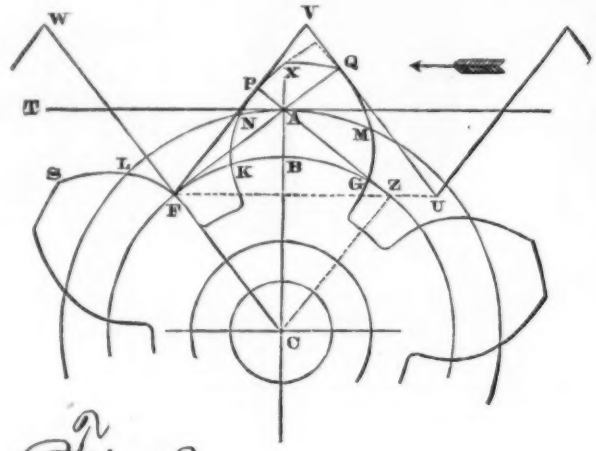


Fig. 2.

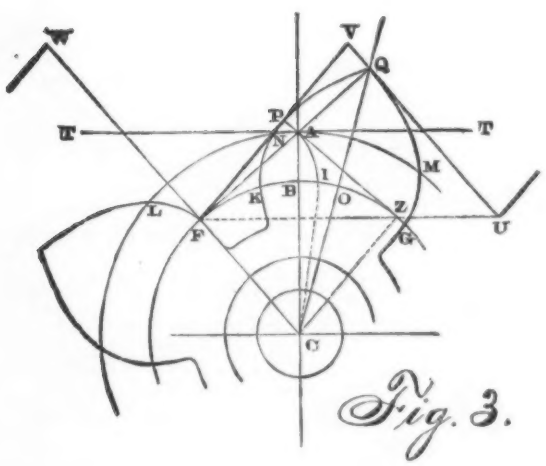
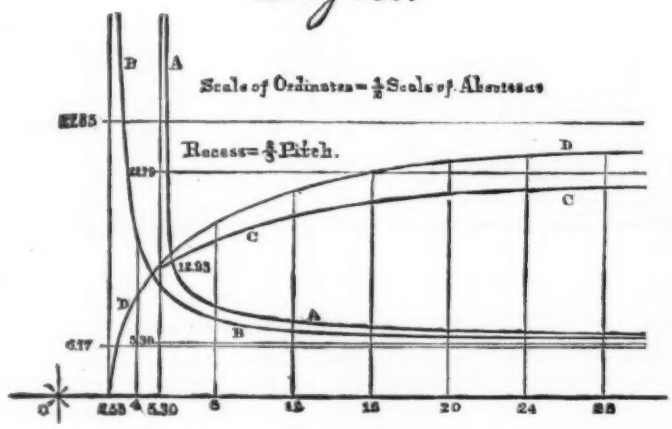


Fig. 3.

Fig. 4.



Radii of Drivers.

rotating through the arc M A; in the reverse motion, a marking point in going from P to A traces the curve P N, while the pinion turns through the arc N A. But,

$$MA + AN = MN = \tfrac{1}{2}ML,$$

whence, $QA + PA = \tfrac{1}{2}QF;$

or, $PA = \tfrac{1}{2}QF - QA;$

also, $QA = QF - AF;$

therefore, since Q F is equal to the pitch arc and A F to the arc of recess, both measured on the base circle, P A is known when those arcs are given.

We have then this simple graphic process: Draw any line F Q, and let it represent the pitch; set off upon it a distance F A, making,

$$\frac{FA}{QF} = \frac{\text{arc of recess}}{\text{pitch arc}};$$

next determine P A as above, and construct the right-angled triangle A P F. Then the angle P A F is twice the obliquity, and A T bisecting it is the pitch line of the rack. Draw A C perpendicular to A T, and F C perpendicular to F Q, these will intersect at C the center of the pinion, determining C F the radius of the base circle and C A that of the pitch circle.

made equal to the pitch. There will be, then, some value of the arc of recess which will cause the points Q and X to coincide. And it is apparent that when this limit is reached, as in Fig. 3, the pinion will have the least possible number of teeth which can be driven by any rack.

Now if in this diagram the arc F I be given, we know F A, the trigonometrical tangent of the angle A C F, which is always one-half the angle P A F; whence A P may be found. We have also,

$$AQ = AF - 2AP,$$

and $$AQ + AF = FQ = \text{arc } FG \ldots\ldots\ldots\ldots (A.)$$

Again, in the previous equations,

$$FG = FR + 2\,RH,$$

$$FO = FR + \frac{3\,RH}{2} - BI.$$

we have FR = O, whence

$$FG = 2\,RH,$$

$$FO = \frac{3\,RH}{2} - BI,$$

or, $$FO = \tfrac{3}{4}\,FG - BI. \ldots\ldots\ldots\ldots (B.)$$

The tentative processes of computation, above explained, are undeniably tedious, yet when systematically conducted they are less so than might be supposed. In the preparation of the following tables, they have been continued until with a radius of 10, the linear values of the arc F G and the path of contact F Q agreed up to the sixth decimal place; the approximation being therefore to within the one-millionth part of the radius of the base circle.

It was not to be expected, that for a given number of teeth upon either wheel, the radius of the other as thus determined would correspond to an exact whole number of teeth upon its periphery. The next higher integer being of course taken as the tabular number, the tooth would not then be absolutely a pointed one. But we have not made any correction for the slight change in the obliquity due to this circumstance, considering its value as appearing in the calculation, which we have given to the nearest second, sufficiently precise for all practical purposes.

It is proper to point out that these tables may be of service, not only as indicating exact limiting cases, which are to be avoided when possible, but upon another account, viz.: Although in general terms the obliquity of the line of action is said to be arbitrary, yet in constructing for special purposes wheels with a given arc of recess, it may be neces-

sary to use numbers not far removed from limiting values, and in many cases the possible variation in the obliquity is confined to quite a narrow range.

But the labor of computing the tables was undertaken mainly with the object of making a fuller comparison than has yet been made between the two leading systems of gearing: and to facilitate this, the limiting numbers and the maximum obliquities for epicycloidal, are here given side by side with those for involute teeth.

One striking point of difference will at once be noticed. In the epicycloidal system, as the arc of recess diminishes, the least number for the driver also diminishes, and the obliquity is always zero at the limit where the follower becomes a rack.

In the involute system, on the other hand, this obliquity rapidly increases, while the number for the least driver remains practically the same, varying but little even at the limit.

The reason is not far to seek. The generating circle for the driving *face* of the epicycloidal tooth, which alone has to do with the receding action, is different from and wholly independent of that for the flank, which produces the required amount of approaching action.

But the outline of the involute tooth is one continuous curve, and the rectilinear generatrix, or line of action, is the same for the part without the pitch circle and the part within. The sum of these two segments must always be at least equal to the length of the pitch arc on the base circle. If, then, the outer one, upon which the arc of recess depends, be decreased, the inner one must be correspondingly increased; and this obviously involves a greater obliquity.

LIMITING NUMBERS OF TEETH.

RECESS=PITCH.					TOOTH=SPACE.				
INVOLUTE.					EPICYCLOIDAL.				
Const. Obliquity.			D.	F.	D.	F.	Max. Obliquity.		
0°	0′	0″	5·58	∞	5·58	∞	0°	0′	0″
2°	28′	42″	6	146	6	144	2°	30′	
7°	0′	47″	7	52	7	50	7°	12′	
10°	17′	4″	8	35	8	34	10°	35′	18″
12°	45′	5″	9	28	9	27	13°	20′	
14°	40′	33″	10	24	10	23	15°	39′	8″
15°	54′	56″	11	22	11	21	17°	8′	34″
17°	26′	26″	12	20	12	19	18°	56′	50″
18°	17′	57″	13	19	13	18	20°		
19°	2′	37″	14	18	14	17	21°	10′	35″
20°	17′	4″	15	17	15	16	22°	30′	
21°	26′	34″	18	16	17	15	24°		
22°	43′	40″	20	15	20	14	25°	42′	51″
24°	10′	12″	25	14	24	13	27°	41′	32″
25°	47′	45″	34	13	32	12	30°		
27°	38′	12″	59	12	57	11	32°	43′	38″
29°	44′	6″	515	11	382	10	36°		
30°			∞	10·88	∞	9·83	36°	37′	21″

LIMITING NUMBERS OF TEETH.

RECESS=⅓ PITCH.					TOOTH=SPACE.				
INVOLUTE.					EPICYCLOIDAL.				
Const. Obliquity.			D.	F.	D.	F.	Max. Obliquity.		
					3·25	∞	0°	0′	0″
16°	2′	40″	5·46	∞	4	34	7°	56′	28″
17°	59′	6″	6	15	5	19	14°	54′	4″
20°	43′	34″	7	13	6	14	19°	17′	8″
23°	43′	27″	8	12	7	12	22°	30′	
24°	14′	35″	9	11	8	11	24°	32′	44″
25°	13′	56″	10	10	9	10	27°		
27°	38′	12″	13	9	11	9	30°		
30°	29′	58″	20	8	16	8	33°	45′	
33°	56′	54″	70	7	33	7	38°	34′	16″
35°	46′	57″	∞	6·54	∞	6·35	42°	31′	11″

RECESS=⅔ PITCH.					TOOTH=SPACE.				
INVOLUTE.					EPICYCLOIDAL.				
Const. Obliquity.			D.	F.	D.	F.	Max. Obliquity.		
					2·58	∞	0°	0′	0″
					3	37	6°	29′	11″
					4	15	16°		
21°	32′	59″	5·30	∞	5	11	21°	49′	6″
23°	38′	20″	6	10	6	10	24°		
24°	57′	30″	7	9	7	9	26°	40′	
27°	38′	12″	9	8	8	8	30°		
30°	53′	47″	12	7	11	7	34°	17′	9″
34°	55′	12″	28	6	21	6	40°		
37°	58′	55″	∞	5·36	∞	5 17	44°	35′	18″

THE NOMODONT, OR CURVE OF LIMITING NUMBERS.

It hardly needs argument to show that if the number of the teeth upon a given wheel be increased, other things remaining unchanged, the least number for the wheel which can drive it, or be driven by it, will vary according to some regular law. And, as in many other cases, this law can most clearly be illustrated graphically. Thus, if on a horizontal line we set off distances proportional to the radii of given drivers, and at the points thus fixed set up ordinates proportional to the minimum values of the radii for the corresponding followers as determined by the computations, the curve which passes through the extremities of these ordinates will exhibit at a glance the peculiarities of the law of variation, giving a clearer idea of its nature than could be acquired by a study of the tables: and the regularity of the curve, or the lack of it, will also serve as a quite rigid test of the accuracy of the calculations.

Since the radii are directly proportional to the numbers of the teeth, we have given to this curve the appellation "Nomodont"; and for the purpose of facilitating the comparison of the laws of variation in the two systems of gearing, we give, in Fig. 4, two of these curves, one for the involute and the other for the epicycloidal system, drawn to the same scale and under like conditions.

The arc of recess is here taken at ⅔ the pitch, and the scale for the abscissas is twice that for the ordinates. Referring to the table, we see that with this arc of recess, on the involute system a wheel with the fractional number of 5·30 teeth can just drive a rack; therefore the vertical ordinate at the distance of 5·30 from zero will be an asymptote to the curve A A, which represents the law of that system. When the driver becomes a rack, that is, when the number of its teeth is infinite, the corresponding number for the follower is 5·36; at that distance above the axis of abscissas, then, this curve has a horizontal asymptote. These distances for the curve B B, which represents the law of the epicycloidal system, are 2·58 for the vertical, 5·17 for the horizontal asymptote.

The same graphic method also illustrates most clearly the law of variation in the obliquities: thus, the ordinates of the curves C C and D D are proportional to the tabular values of the obliquity for involute and epicycloidal teeth respectively, the abscissas, as before, representing the numbers of teeth of given drivers. These ordinates are drawn to the same scale as those of the nomodonts, the numerical value of each one being the one-hundredth part of the obliquity taken to the nearest minute. Thus, the first ordinate for C is the vertical asymptote to A, and its value is

$$\frac{21° 33'}{100} = 12·93.$$

As the number for the driver approaches infinity, the obliquity approaches the limit 37° 59′, as given in the table, and

$$\frac{37° 59'}{100} = 22·79,$$

at which distance above the axis of abscissas this curve C will have a horizontal asymptote.

In like manner, we find that the curve D D has also a horizontal asymptote, at a distance of 27·85 above the axis of abscissas. But this curve, instead of beginning abruptly like the other, and intersecting the vertical asymptote of B B, is tangent to that line at its foot.

SPECIFICATION OF ORGAN AT TEMPLE CHURCH, LONDON.

GREAT ORGAN. (1)

1. Double diapason (closed).....16 feet.
2. Large open diapason..... 8 feet.
3. Small open diapason ..... 8 feet.
4. Stopt diapason..... 8 feet.
5. Hohl flute..... 8 feet.
6. Viol de Gamba..... 8 feet.
7. Principal..... 4 feet.
8. Octave..... 4 feet.
9. Nason flute..... 4 feet.
10. Twelfth..... 2⅔ feet.
11. Fifteenth..... 2 feet.
12. Full mixture..... 3 ranks.
13. Sharp mixture..... 3 ranks.
14. Large trumpet..... 8 feet.
15. Small trumpet..... 8 feet.
16. Clarion..... 4 feet.

SWELL ORGAN. (2)

17. Bourdon.....16 feet.
18. Open diapason..... 8 feet.
19. Röhr Gedackt..... 8 feet.
20. Salcional..... 8 feet.
21. Vox Celeste..... 8 feet.
22. Principal..... 4 feet.
23. Röhr flute..... 4 feet.
24. Twelfth..... 2⅔ feet.
25. Fifteenth..... 2 feet.
26. Mixture..... 5 ranks.
27. Double bassoon.....16 feet.
28. Horn..... 8 feet.
29. Oboe..... 8 feet.
30. Vox humana..... 8 feet.
31. Clarion..... 4 feet.
32. Spare slide.....

CHOIR ORGAN. (3)

33. Lieblich Bourdon.....16 feet.
34. Violon diapason..... 8 feet.
35. Lieblich Gedackt..... 8 feet.
36. Spitz flute ..... 8 feet.
37. Dulciana ..... 8 feet.
38. Flaute Traverso ..... 8 feet.
39. Gemshorn..... 4 feet.
40. Violin..... 4 feet.
41. Lieblich flute..... 4 feet.
42. Mixture..... 3 ranks.
43. Basset horn..... 8 feet.

SOLO ORGAN. (4)

44. Flute harmonic..... 8 feet.
45. Flute Octaviante..... 8 feet.
46. Piccolo harmonic..... 8 feet.
47. Tuba..... 8 feet.
48. Clarinet..... 8 feet.
49. Orchestral oboe..... 4 feet.

PEDAL ORGAN. (5)

50. Sub-bass.....32 feet.
51. Major-bass.....16 feet.
52. Open-bass.....16 feet.
53. Viola .....16 feet.
54. Stopped-bass.....16 feet.
55. Quint .....10⅔ feet
56. Violoncello..... 8 feet.
57. Principal..... 8 feet.
58. Twelfth..... 5⅓ feet.
59. Fifteenth..... 4 feet.
60. Trombone.....16 feet.

COUPLERS. (6)

1. Swell to great.
2. Swell to choir.
3. Choir sub-octave to great.
4. Solo to great.
5. Great to pedals.
6. Swell to pedals.
7. Choir to pedals.
8. Solo to pedals.
9. Pedal octave.
10. Tremulant to swell.

Compass (manuals) CC to G^3.
Compass (pedals) CCC to F.

CHEMIGRAPHIC ENGRAVING.

THE asphalt process of Niepce is capable of giving by far the finest result of any heliographic method known, when line subjects are to be reproduced; and the application of this method to chemigraphic engraving on zinc has long been practiced with success. The asphalt process on zinc gives clearer and more perfect blacks than the transfer method already described, as the protective film of asphalt is continuous, and not a mere net-work like the blacks transferred from the usual photo-lithographic impression. Till recently, the great length of exposure required to sufficiently impress the bitumen film has largely tended to prevent the bitumen method coming into general use; but by the adoption of the mode now given for preparing the bitumen solution, this objection is removed, the exposure required not being very much in excess of that required in the case of the bichromated gelatine process. Reversed negatives are required for the process now under consideration, and these are most conveniently obtained by using a reflecting prism or a mirror when taking the negative.

The asphalt selected for preparing the sensitive solution should be light brown in color and have a decided odor, and, at the same time, should not be so exceedingly dry and resinous as to be easily crushed into an extremely fine powder. A quantity of the sample selected should be powdered as finely as possible, and put into a bottle so as to about one-third fill it; after which the bottle is nearly filled with ether. The bottle should now be corked, and agitated at intervals during about five hours, when the powder is allowed to settle, and the clear ethereal liquid is poured off. This washing with ether is repeated several times—in fact, as long as the ether dissolves anything out of the bitumen—after which the remaining asphalt powder is collected on a filter, and allowed to dry in a warm and dark place. The dry powder thus obtained is dissolved in benzole, so as to form a solution having about the consistency of ordinary black varnish or Brunswick black, and the solution is stored up in a dark place for use.

The zinc plate having been carefully cleaned and prepared as directed in the case already considered, a portion of the bitumen solution is diluted with about its own bulk of anhydrous benzole, the solution being filtered if necessary; after which the plate is coated, just as a glass plate is coated with collodion, and placed in a warm and dark place to dry. Before exposure under the reversed negative it is well to dust the surface of the bitumenized plate over with French chalk, in order to prevent its adhesion to the negative; but, of course, all excess of French chalk should be wiped off before the plate is placed in the printing-frame. In ordinary cases, an exposure of one or two hours is required in good diffused daylight. It is scarcely necessary to say that great care must be taken to insure the complete contact of the negative with the coated zinc plate.

The exposure being ended, and the plate taken into the dark room, its surface is carefully mopped over with a tuft of cotton-wool moistened with oil of turpentine; after which, extremely gentle friction may be applied with the same tuft of wool, the greatest care being necessary to treat all parts of the film with equal force. Under these circumstances, the unexposed portions of the film gradually dissolve away, and the device appears in sharp brown lines on the plate. The development being complete in all parts, a similar tuft of wool charged with olive oil is applied in a like manner, this operation serving not only to arrest the solvent action of the turpentine, but also to remove the bitumen already dissolved by the essential oil. The excess of oil having been wiped off, the plate is gently scrubbed with a tuft of cotton charged with a lather of soap and water, this operation being alternated with washings under a water-rose. When all traces of oil have been removed, the bulk of the water is removed by means of blotting-paper, and the plate is fanned till perfectly dry, and placed in a good light for an hour or so, in order to thoroughly fix the bitumen film. The edges and back of the plate are now covered with a resist of shellac varnish, test lines are made, and all is ready for the immersion of the plate in the first etching bath of one part nitric acid and forty parts of water, as already described. When the first etching is completed, the plate is rinsed, gummed, and inked, just as described in the preceding articles. All subsequent operations are now identical with those already described in connection with the transfer process.

Any of our readers who may experience difficulties in carrying out our directions in actual practice are invited to communicate with us.—*Photo. News.*

WHALEBONE.

THE principal application of whalebone now is that in making whips and corsets. Steel has mostly displaced whalebone in umbrellas and parasols. Some years ago umbrella ribs were made in France of an excellent imitation of whalebone (not distinguishable, indeed, till fractured); but it is no longer heard of. Genuine whalebone is often made white and used with garments of muslin or the like, not being seen through these so easily as the dark sort. The newest application of whalebone is that to hats; it is cut into fine strips and interlaced with straw. Such hats are very dear. Another novelty is "whalebone ribbon." For this white whalebone is generally used, and the shaving is so thin that ordinary print can be read through it. It is often colored blue, red, or green and used by saddlers in making rosettes. Walking sticks of whalebone are also in good demand. The exceptionally thick strips cut for this purpose are rounded by being drawn through holes in a steel plate. Billiard pads of whalebone must be very smooth and cut of a certain exact thickness. Fishing rods are made of two carefully worked strips of whalebone with thick silk thread wound round them. Penholders and other small articles are made of whalebone at the lathe. The hair cut off the raw whalebone was formerly used for brushes, but it is now mostly replaced by other materials. It is largely crisped and used as a filling for mattresses. This list by no means exhausts the uses of whalebone, which is continually being applied in new ways.—*London Times.*

URO-ROSEINE, A NEW PIGMENT.—This pigment was first found on adding pure hydrochloric acid to the urine of a diabetic patient. In four other cases of the same disease it was absent. Hitherto it has not been detected in the urine of healthy persons, but in that of about 10 per cent. of patients affected with chlorisis, osteomalacia, nephritis, typhus abdominalis, etc. It is of a beautiful rose color, dyes wool and silk, and may be separated from urine by gentle agitation with amylic alcohol. It is very unstable, and has not yet been sufficiently purified for analysis.—*M. Nencki and N. Sieber.*

PICTURES IN GLASS.

THESE six cartoons, designed and executed by Messrs. Clayton & Bell, of Regent Street, London, are in white and delicately tinted glass, with here and there a bright fragment of primary color to give a crispness and luster to the whole. The glass occupies the staircase window at Messrs. Howard & Co.'s new premises in Berners Street, and the subjects chosen were selected as illustrative of the several building trade arts carried on by the firm. The history of wood is given by the three upper drawings, where the woodman felling the tree is supported on either side by the carpenter and the joiner. Below these, on one sheet, is the carver and the designer of parquet flooring In the latter panel brass work and decorative hangings are shown. Painted glass, too, is indicated, as in the panel where the carver is placed. Decoration is the last cartoon, illustrating the artist at work on a jamb reveal. Behind the painter is a cabinet representing furniture.—*Building News.*

CARPENTRY. WOODMAN. JOINERY.

CARVING. PARQUET FLOORING. DECORATION.

SUGGESTIONS IN DECORATIVE ART.—SIX CARTOONS IN GLASS.

ENGLISH IDEAS OF AMERICAN ARCHITECTURE.

AT a recent meeting of the Royal Institute of British Architects, Mr. A. J. Gale read a paper descriptive of his recent tour in the United States, as the first holder of the Godwin Bursary. A large number of illustrative plans and photographs, given to the author by American architects, were hung on the walls of the room. Mr. Gale explained that his stay in America extended over ten weeks, and was begun and ended at New York, the cities of Philadelphia, Baltimore, Washington, Detroit, Niagara, Boston, Newport, R. I., being visited during the tour. In New York, where a large portion of his time was spent, the lecturer paid considerable attention to the work of the Board of Health, and the improved class of tenement houses now in course of erection. A marked feature of that city was the large blocks of offices rising in the principal thoroughfares, each larger, loftier, and more ambitious than its predecessors. One of these blocks, known as Mill's Offices, Wall Street, finished in May last, was described in detail. It was nine stories in height, exclusive of the basement, which was used as cellars and closets. Each of the other floors was arranged in suites of offices, with conveniences on each floor, and a lavatory. The lighting throughout was good and sufficient. On the ground floor a large entrance hall, in the center of the building lighted from a well hole in the roof, opened on the sides to four elevators, which were continually running by hydraulic power to the upper floors. A single staircase was provided, but was little used. The stories varied in height from 17 feet, 16 feet, and 12 feet to 9 feet, and the walling materials were bricks, with terra cotta panels. The treatment was a plain type of classic with marked vertical and horizontal lines, the result being, in the lecturer's judgment, successful. The staircase was of wrought iron, with slate treads and landings; the walls of corridors were lined with white tiles. The roof was flat, laid with asphaltic cement, on which roofing felt was laid, and over this a pavement of best hard bricks laid on edge. Mr. George B. Post was the architect, and the draw-

ings were prepared and the building partially completed and occupied within twelve months of the owner's decision to build—an instance of the rapidity of execution required in the States. The heating was by steam, by visible coils on the direct radiator principle, which was more popular, and was supposed to be less noxious, than the indirect system. The plans he had described were typical of the newer groups of offices building in New York.

The apartment houses were a marked feature of the city, and were a result of the exorbitant rents and small accommodation provided in separate dwellings. They were enormous blocks of buildings, seven or eight stories high, and since 1879-80 had been strictly regulated by the New York Board of Health, some particulars of which organization were given. All classes of apartment houses were subject to the same regulations, and were constructed on much the same plans and lines, but in some a great amount of luxury was afforded the tenants. The entrance halls opened upon elevators with well cushioned seats, and, running very easily, and the buildings surrounded a courtyard, covered in in the best examples. The walls were of brick, the roofs of iron, covered with slates, or, if flat, of felt and brick paving, the staircases of iron, and the floors of iron bedded in concrete, and laid with two thicknesses of boards. The finishing of all woodwork was excellent, and the joinery was superb, and constructed in a great variety of woods. Some of these dwellings were erected by mutual associations, who thus preserved some power of choice of tenants, and in many cases the choice of apartments was put up to auction. During the past year the plumbing arrangements had been regulated by the Board of Health, and the rules were fairly representative of American public opinion on the matter. A curious feature was that the soil pipe was usually of iron, coated inside and out with enamel or coal tar pitch. The use of iron allowed the pipes to be suspended from the cellar roof. Lead was condemned as being less smooth, less liable to corrosion, and less easy of jointing. Indeed, there was a general thoroughness about the use of iron pipes which was in advance of English practice. Thus, at Chicago and elsewhere, the author found a still further advance in drainage details. Vertical wrought iron pipes, coated with coal tar, and having screw joints, were carried through the house and supported all the w. c. apparatus, etc., and from these horizontal pipes of cast iron, similarly protected, were carried along the cellar roof, so that no leakage could take place unperceived. The same system was in operation in the town which Pullman, of car fame, had built for his work people, and, in its main features, this plan was adopted in Boston and other Eastern towns.

The ventilation of buildings was, in many cases, very perfect, and he specially studied the instance of Dr. John Hall's church (Fifth Avenue Presbyterian), New York, of which M. Carl Pfeiffer was the architect. The building measured 200 feet by 100 feet, and was 60 feet high, being seated for over 2,000 persons. Two towers, each 100 feet high and 16 feet square, formed inlets and outlets for air. The incoming air was received in basement, and in cold weather passed over a set of steam pipes some 9,000 feet long, suspended from the ceiling, the whole basement being thus converted into a heating chamber. The warmed air came up into the pews, and could be regulated by the occupants. Twenty-four hours before the service the steam pipes were heated, and throughout the Sunday a powerful fan was rapidly rotated in the outlet tower, drawing off the vitiated and heated air. The windows were all double, and the gas burners protected in glass niches. In summer time, the incoming air was passed over ice. A steam pump and fire hydrants were provided to prevent accidents. Madison Square Theater, in the same city, was ventilated, and warmed or cooled, by somewhat similar apparatus.

A work of the first magnitude, now in progress at Philadelphia, was the new public buildings. It covered an area of nearly 4½ acres, the sides being 470 feet by 476 feet, and was classic in style. The ground story, 18 feet 3 inches high, was built of a fine white granite, and the superstructure, consisting of several stories, 33 feet 6 inches, and 35 feet 7 inches, 26 feet, and 24 feet high, according to the position, were faced with a beautiful white marble from Lee, Mass. Above these buildings, which were broken up by projecting wings, rose pinnacles and domed roofs, and in the center of north front was being erected an enormous tower 90 feet square, and intended to rise to a height of 525 feet. This tower was carried on a massive bed of concrete, would be crowned by a statue of William Penn, 35 feet high, and was expected to be the loftiest artificial erection in the world. Every room in this great building would, when finished, be well lighted, warmed, and ventilated, the latter desideratum being met by indirect radiation. No attempt would be made to render the building absolutely fireproof; the floors would be of brick, and the constructional ironwork was not protected. The roofs were of iron framing, slated, the large slates used being held together by brass screw nuts, and the flashings were to be of tinned copper. The architect of this pile was Mr. McArthur, whose design was selected in competition in 1869. From 1870, when it was commenced, to 1879, the date of the last official return, the building had cost $5,857,618, and the total estimated cost was set down at $10,000,000.

The post office in the same city was a good example of Government work; all post office plans and designs were prepared at Washington by Mr. James G. Hill, supervising architect, and were erected under the inspection of an official upon whose certificates payments were made. No quantities were prepared for builders. In this post office at Philadelphia, all the blocks of stone were prepared in the quarries and put together when they arrived, on the building, without chiseling. Bricks were used for backing here, and also in the public buildings of the same city just described, and were of the usual size adopted in the Eastern States, 8 inches by 4 inches by 2¼ inches.

The Johns Hopkins Hospital, at Baltimore, would, when completed, be one of the most interesting structures of its kind in the world. All the details had been devised by Dr. Billings, who was commissioned by the trustees to visit all the chief hospitals in Europe before beginning the works, and in the architectural arrangements Dr. Billings was associated with Messrs. Cappitt and Chandler, of Boston, and Mr. John R. Niernsée, of Baltimore, joint architects. The hospital occupied a lofty site bounded by four streets, and consisted of two rows of one story buildings connected by corridors, the administrative block being at one end. All the wards faced east and west, and ample space had been left between for providing tents in cases of epidemics. The heating was by hot water on a low-pressure system, which, although slow, was regarded as satisfactory in working. The ward floors were seven feet above the external ground level, and coils of hot water passed direct into the wards. By means of a fan and air duct the air of wards could be flushed out each morning and evening. The walls were of red brick, and the dome of "lime of teil."

At Detroit, Mr. Gale said he visited Mr. Gordon Lloyd, nephew of their chairman, who was practicing as an architect in the city, and who was one of those who used cast iron for building purposes, contending that the material was more durable and cleanly than stone. Iron buildings in that city were of two types, the skeleton and the block. In the former, which seemed the better of the two, the framework was of three-eighths inch wrought iron, and was filled in with 12 inch brickwork, set in panels. The ironwork in either case was protected from rust by being carefully coated with Carson's anti-corrosive paint, which was said only to require repainting once in 20 years, and against fire by being encased in wood or concrete. The cornices to these and many other houses were of galvanized iron.

Boston, Chicago, and several other cities had suffered so severely from fires, that great care was taken to prevent its spreading. The author visited at Chicago the factory of a Mr. White, who was originally an architect, but had turned his attention to this subject. His plan was to encase all constructional ironwork with porous terra-cotta tiles, fastened by clips, and rendered air tight by Keene's cement. The extra cost of fireproofing was set down at from 15 to 18 per cent. In New York, lime of teil floors, on flat brick arches, were common; partitions were built hollow of lime of teil, and were plastered, and roofs, if not flat, were of the same material, covered with terra-cotta. Mansard roofs in that city were of teil blocks with iron supports and slate covering.

Speaking especially of the North-eastern States, he was informed that the climate was subject to great extremes of heat and cold; and as at Albany, N. Y., the ground was frozen to a depth of 3 feet 6 inches, open drain pipes and half timbered constructions were alike impracticable. Wooden houses were found to be the best. For joinery very small sizes and small scantlings were employed; the cost of materials was low, but labor was very expensive.

He was impressed with the wonderful completeness of American houses and the elaboration of their construction. These were very expensive, but clients seemed willing to pay for any comfort that could be procured. As to the artistic character of American architecture, although a few years ago this was inferior to our own, yet great progress had been made of late in this respect. Many American artists and architects were trained in Paris and Italy, and returned to the States well qualified for practice.

Mr. J. Slater, B.A., proposed a vote of thanks to the lecturer, who had shown that the States was *par excellence* the place for "tips" for the young architect. The necessity for economizing labor rendered the American quick in devising mechanical contrivances, and the workmen who had a training in that country also possessed this quality. Their ingenuity was also seen in the numerous contrivances for utilizing waste products. English architects and builders alike were apt to run in grooves, and they could, therefore, learn much from such a paper as Mr. Gale had read that evening. He supposed that want of time had prevented the lecturer from alluding to the public schools of America. About two years since, the Education Department at Washington issued a pamphlet on rural school architecture which was exhaustive yet simple, and far in advance of anything that had been published in this country.

Mr. Hugh McLachlan seconded the motion, and asked how the interiors of iron fronted dwellings were protected from extremes of climate, and also how rust was prevented from attacking the encased and fireproofed ironwork.

Mr. Andrew T. Taylor had, like Mr. Gale, just returned from the States, and wished to support the vote, and to endorse most of his statements. The advance that had been made during the past few years in matters of artistic taste and style among American architects was wonderful, and it would be difficult to match many of their more recent buildings in London. American householders were willing to spend enormous amounts in finishing their interiors in hard woods. Vanderbilt's house, in New York, was simply dazzling in its magnificence. A style for cast-iron architecture had yet to be evolved, and the problem of its satisfactory treatment was still unsolved. The practical result of the noiseless and easy lifts or elevators in use in New York was that rents for upper floors of offices were nearly the same as those below—a very important consideration to the capitalist. The enormous tower of the new public buildings in Philadelphia had not, a month ago, advanced beyond the roof, and it was very doubtful whether it would ever be completed. He could not speak so highly as did the lecturer of the post offices and other buildings built from designs furnished by departments at Washington; the details were utterly poor and insipid, and were repeated continuously.

Mr. P. Gordon Smith, of the Local Government Board, asked whether there was a ring of suburbs outside New York in which the jerry builder flourished, and how the New York Board of Health dealt with that practitioner?

The Chairman, in putting the vote of thanks, said from his recent visit to America he could confirm very much of what Mr. Gale had said in his thoughtful and excellent paper. He had himself been impressed with the enormous scale of buildings in Philadelphia and other cities, but still more with the goaheadedness of the people. A man brought out a new invention, it was flashed through the States, and if there was anything in it, it was at once brought into use and employed till it, in turn, was superseded by another idea. The telephone was far more generally adopted in small towns than it was even in London, and was a marvelous economizer of time and labor. As to ventilation, Dr. Hall's church in New York was, in his opinion, simply perfect; the freshness of the air was remarkable, and the luxuriousness which marked the heating and ventilating was carried throughout; thus, he estimated that it ought to sent 3,000 persons, but the seats were so arranged that only accommodation for 2,000 was provided. He regretted to learn that his nephew and former pupil, Mr. Gordon Lloyd, had become a heretic in the matter of iron fronts. A well known and early example of these was A. T. Stewart's stores in New York. The temperature in these iron-fronted buildings was maintained by the large air spaces behind the fronts, and in cold weather the better classes of American houses were kept at a uniform internal temperature of from 65° to 70° by means of steam heating.

Mr. Gale, in reply, said his American experience was not such as to enable him to say if there were jerry builders there. He did not go across the Atlantic with the object of studying their works. Dr. Hall's church was seated for fewer persons than we should accommodate in such a building. The iron fronted houses were rendered equable in temperature by the provision of air spaces between the walls, rendering heating comparatively easy. The joints were lapped so as to give great play to the shell. Mr. A. T. Stewart's stores in New York was one of the early and bad examples of iron architecture; it combined classic columns and elliptical arches with most unpleasing effect. In many more modern cases the architect adhered to simple horizontal and vertical lines with more satisfactory result. The encased columns were hermetically sealed, and were thus in every case preserved from the ravages of rust. In conclusion, the lecturer defended the massing and general treatment of the post office designs, prepared at Washington, from the charges of insipidity and monotony that had been brought against them.

DAS TELEPHON.

In the annual reports of the Physical Society of Frankfort of 1860-61, we find published a lecture by Reis, in which he said: "While pursuing my studies of the organ of hearing, I succeeded in the construction of an apparatus with which sounds could be sent to distant places with the assistance of the galvanic currents, and could be reproduced. I gave to the instrument the name 'das Telephon.'"

The Natural Philosophical Society of Giessen and the University of Hesse-Darmstadt complimented Mr. Reis on this invention.

This appears to be the first reliable evidence that "sounds could be sent to distant places with the assistance of the galvanic current, and could be reproduced."

The Reis telephone consisted of an instrument by which undulatory currents of electricity can be produced in a closed circuit, which instrument may be called the transmitter; it has been said empirically that this transmitter did not work with a closed circuit, but with a broken circuit, and therefore did not act as a tension regulator. An examination and trial of the instrument proved conclusively that it does act as a tension regulator, and further that articulate speech can be reproduced in any good receiver when this instrument is used for transmitting. This instrument has a diaphragm with contact points provided with a spring and an adjusting screw; the contact points are made of metal, one of them being attached to the diaphragm, and the other to a spring, the initial pressure of the contact being determined by a screw. The pressure of the electrodes at the contact point is more or less according to the vibrations of the diaphragm; and the electric current from the battery rises in tension as the pressure on the contact points increases, and lessens as the pressure diminishes. It is by no means necessary that the contact points in a tension regulator should be of a material of low conductivity.

The Reis transmitter differs from the Edison transmitter only in *one* thing, namely, in the material of the contact points. Edison used "lampblack or a fiber, such as particles of silk rubbed with plumbago or soft metal," this material being squeezed between the diaphragm and the spring. In the same way does the Reis transmitter work, and it is an instrument capable of producing a rise and fall of electric tension in a closed circuit, according to the vibrations of the diaphragm. There is no doubt that the vibrations of the tensions of the current are greater with contact points of a material of low conductivity than with one of high conductivity. Can it be denied that the transmitter of Reis was the combination of a diaphragm with a tension regulator?

The other part of Reis' telephone is the receiving instrument, or to name it more correctly, the sound producing instrument. This instrument consists of an electro-magnet made so by a current passing though the coils on it from the line-wire, with a bar or plate armature in front of, but not capable of coming in contact with, the poles of the magnet; the vibrations of which armature are communicated to a sounding box through a metallic bar attached to it, the other end of the bar being attached to one end of the armature. These two instruments when connected together by metallic conductors—in the circuit of which is placed a battery—operate as follows: When air-waves fall upon the diaphragm of the transmitting instrument, a rise and fall of the tension of the electric current results from the greater or less intimacy of surface contact of the electrodes; and the magnetic force of the electro-magnet at the other end of the circuit varies with the rise and fall of the tension of the electric current, and the armature in front of the electro magnet vibrates in accord with the variations of the magnetic force of the magnet, and these vibrations of the armature are communicated to the sounding box. It is not denied by any one that these combined instruments of Reis reproduced musical sounds at a distance with the assistance of galvanic currents, and can any one refuse to accord to Reis, the poor artisan of Frankfort, the honor of having invented the telephone?

It is said his telephone was only capable of reproducing musical notes, and that it was incapable of reproducing articulate speech. Several eminent electricians have given opinions that the Reis telephone, that is, the Reis transmitter and the Reis receiver, could not successfully reproduce articulate speech. Are *opinions* of experts to outweigh the positive statements of other scientific men—that the Reis telephone does produce articulate speech? It has been urged that the reproduction of articulate speech by the Reis instrument was not obtained until after Prof. Bell's instrument had been made public. Let it be assumed that such is the fact. Yet, if the *original* Reis instrument, without any alteration whatever, speaks now, does it not remain an indisputable fact that Reis was the original inventor of a speaking telephone? It has been urged that the information obtained from the construction and working of the Bell telephone enables persons to obtain articulate speech from the Reis telephones; also that, if the transmitter were spoken to in a loud tone, there would be makes and breaks of the circuit, and consequently intermittient currents, and not undulatory currents, which are necessary to reproduce articulate speech, would be produced.

Did Reis give instructions that persons using his instruments should yell into them at the top of their voices, thereby to render them useless? As well might it be said that the Armstrong gun cannot throw a shot to a great distance if it be charged with powder so as to burst it. There is evidence, however, that the Reis instrument did reproduce articulate speech in 1862, and this fact is sworn to by Mr. J Wilhelm Albert, an agent of Reis, of Frankfort. Can it be denied that Reis was the first inventor of an instrument for producing undulatory currents in a closed circuit? Can it be denied that Reis was the first to use undulatory currents to reproduce sounds with the assistance of the galvanic battery? Can it be denied that Reis was the first to invent an instrument which reproduced articulate speech?

It is one thing to make a great discovery, and quite another thing to utilize it and make it commercially successful. Reis, the poor artisan, without having himself realized the greatness of his invention, died poor, as he had lived, in 1874; and a few years after Prof. Bell had the good tune to announce to the world his speaking telephone, in which the principles of the Reis receiver are found in an in-

strument in which the bar armature of the Reis is changed into a circular armature. The instrument of Prof. Bell was exhibited at the Centennial Exhibition in Philadelphia, in July, 1876, when Sir William Thomson and other eminent scientists heard it *faintly* repeat a few monosyllables. "To be, or not to be," "There's the rub." This instrument was an electro-magnet with an iron cylinder around it, with an iron plate attached at one point only of the cylinder, and tilted at a certain angle from the plane of the top of the cylinder. Sir William Thomson brought one of these instruments to Glasgow, and has "asserted that neither himself nor his assistant could make anything of them." "They were obviously not practically useful instruments, and it was obvious a new invention was necessary before they could be so, because of the exceeding difficulty I had in hearing the words at Philadelphia, and then only when the tilted armature was held pressed down by the ear." In this instrument the vibration of the armature is that of a tongue, as in the Reis instrument; but in this latter the vibratory movement of the armature occasioned a tympanic movement in the sounding board, and it is this tympanic vibration which reproduced speech; whereas the armature of this Bell instrument, evidently enlarged for the purpose of obtaining a greater area of vibrations of the air, fails to reproduce speech.

Such was the instrument for reproducing speech made by Prof. Bell prior to December 9, 1876—the date of his English patent. In the words of Sir William Thomson, "the most important part of this last invention was the substitution for the disk held at one point of a disk held all round its edge." A very slight change, but an all-important one; and this change was the obvious result of the reproduction of speech having been obtained when the tilted disk was pressed down by the ear, thereby preventing any tongue vibrations of the disk armature, at the same time leaving to it tympanic vibrations.

It seems unnecessary to say much of the use Prof. Bell made of this same instrument as a transmitter, because he simply used a well known discovery of Faraday, and, moreover, as a transmitting instrument it has never worked successfully.

Prof. Bell's first patent for instruments supposed by some to transmit and reproduce articulate speech was filed in the United States Patent Office on February 13, 1876, for "improvements in telegraphy," and the specification describes his method of transmitting signals by means of musical notes, but does not speak of transmitting articulate speech; and it is well known the instruments therein described did not reproduce articulate speech, and Prof. Bell himself says, "the gold beater skin instrument is of small utility, owing to its uncertainty of action."

It is then an undisputed fact that prior to December 9, 1876, Prof. Bell had not invented instruments which could reproduce successfully articulate speech. There is in the records of the Patent Office of the United States a full description, accompanied by drawings, of a transmitting instrument and a receiving instrument filed by a Mr. McDonough on April 10, 1876. The transmitter is made on the same principles and almost in the same manner as that of Reis; but the receiver consists of a parchment stretched over a drum head attached to a board; in the center of the parchment is secured a disk of iron, and in front of, close to this disk are the poles of an electro magnet, the coils upon which are in the circuit of the line wires, the battery, and the transmitter. These instruments reproduce perfectly articulate speech; and when this receiver is used with a Hughes microphone and induction coil, the articulation is perfect, the tone full and loud, and it is entirely free from the disagreeable buzzing sound almost constantly found in receivers when an iron disk is used. Here then is a practical receiver made on April 10, 1876, whereas Bell's receiver dates from December 9, 1876.

On January 30, 1877, Prof. Bell applied to the United States Patent Office for a patent for his invention described in his English patent of December 9, 1876; and, strange to say, one of the drawings in this United States patent is a facsimile of the drawing, above described, in Mr. McDonough's application of April 10, 1876.

The name of Prof. Hughes has been incidentally mentioned above, but any remarks about the telephone would be incomplete without giving to that eminent scientist—that lover of science—the credit of having discovered the peculiar properties of carbon which render it so efficient in the microphone, an invention of the same eminent electrician.

"*Palmam qui meruit ferat.*"

—*Das Telephon, in Electrical Review.*

MESSRS. D'ARSONVAL AND BERT'S MICRO-TELEPHONE APPARATUS.

THIS apparatus, like all others of the kind, consists of two very distinct parts—a receiving apparatus and a transmitter.

1. *The Receiver.*—The receiver is a magnetic telephone of peculiar construction that I have made known in a former article. As I have said, this apparatus, which weighs only about twelve ounces, gives excellent results, while preserving the *timbre* of the voice transmitted. With whatever impartiality one seeks to judge of his own works, he is always pleased to see his conclusions confirmed by other experimenters. This is why I permit myself to cite here the appreciation that Mr. Preece, among others, offered at the Southampton meeting on the subject of the receiver under consideration:

"D'Arsonval has, on his side, improved on the Bell receiver. He has placed the bobbin in a powerful magnetic field of annular form, so as to concentrate upon it the lines of force. The induced bobbin is entirely immersed in the magnetic field. Its effects are considerably increased. The increase in the fullness of the voice is in no wise accompanied by loss of articulation, as ordinarily happens; and speech is reproduced without any change in its *timbre*."

The judgment of a man so competent with regard to the question renders it unnecessary to dwell longer on the subject. I will add, however, one interesting detail given by the illustrious English savant in his oral communication. Mr. Preece, in trying my instrument, remarked that it was the only one that transmitted with perfect distinctness the so varied consonances of the English "the."

2. *The Transmitter.*—The transmitter consists of a Hughes four-crayon microphone, distinguished from the original American apparatus simply in the two following points: (1) the mode of regulating the contacts; and (2) the mode of suspension designed to suppress noises foreign to the voice.

As may be seen in Fig. 1, the microphone consists of four carbon rods arranged parallelly on a vertical board of thin wood, and grouped two for quantity and two for tension—an arrangement that M. Maiche appears to have been the first to patent in France.

To prevent the spitting sounds inherent to the Hughes arrangement, I have recourse to the magnetic regulation that M. Paul Bert and I made known in 1879. Such an arrangement adapts itself perfectly and very simply to this sort of

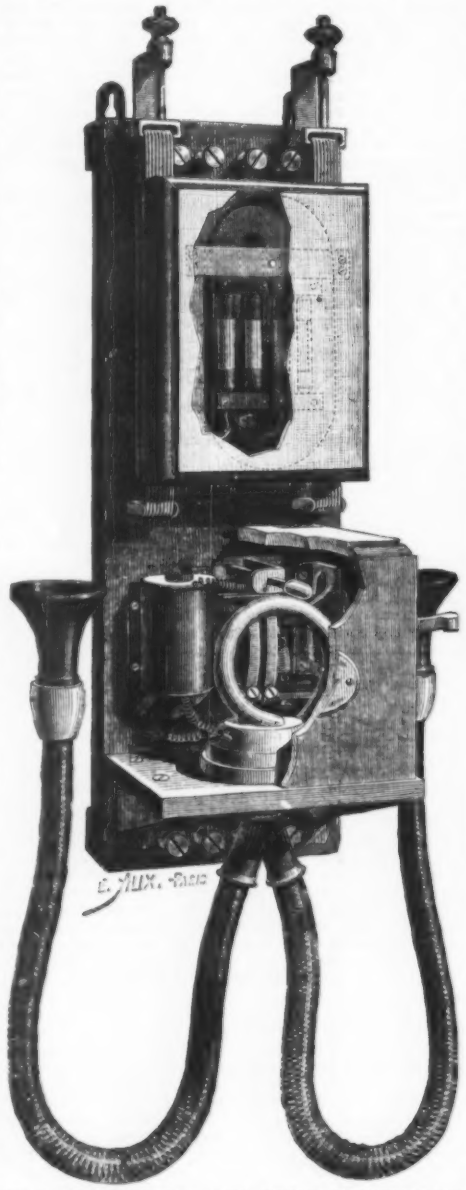


FIG. 1.—D'ARSONVAL AND BERT'S TELEPHONE.

regulating. To this end, each carbon crayon carries in its center a thin sheet of tin rolled around it. Behind the four crayons there is a small horse-shoe magnet; A, that may be made to approach them by means of a simple screw.

This method of regulating the pressure of the carbons gives still more perfect results than gravity does. It presents the double advantage over the latter of permitting the microphone to operate *in every position*, and to receive, *with the same carbons*, a sensitiveness varying with the uses to which the instrument is finally destined. In practice it has been found necessary to reject the use of all kinds of springs for operating the contact, and the reason of this will be understood. Springs, in fact, can transmit pressure only through a rigid intermedium, leading inevitably either to slippings or to vibrations which determine foreign sounds. Gravity and *magnetic attraction*, which *act at a distance*, suppress this inconvenience by that very fact.

In my numerous experiments I have remarked, moreover, that one of the conditions necessary for a good transmission consists in making the vibrating board itself carry the two parts of the microphone—the fixed and movable—so as to always avoid lateral movements and to produce only changes of pressure.

Mode of Suspension.—In ordinary cases the magnetic regulation alone suffices; but when the instrument is to be placed in a shop or any other place where tremors occur, I

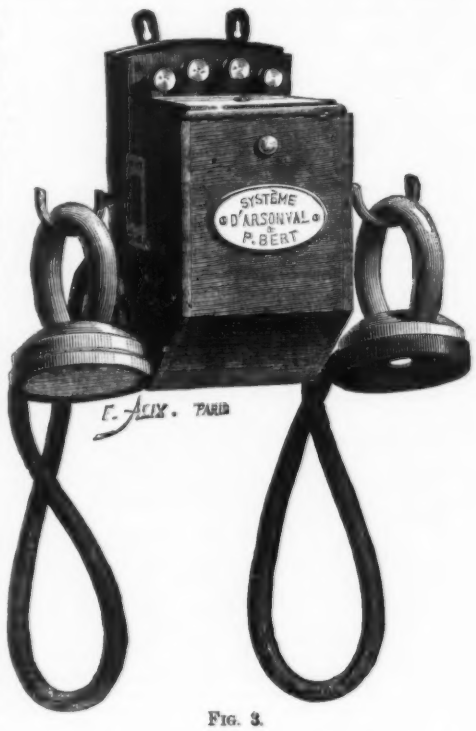


FIG. 3.

have recourse to a very simple system of hanging, which has given me very perfect results.

The microphone board is glued to a small box which carries the directing magnet, and the side of which opposite the microphone is covered with a piece of flannel which forms a deadener. I have remarked, incidentally, that the presence of this piece of fabric considerably improves the voice.

The microphone box is simply suspended from the wall board by means of two very taut elastic bands. This mode of suspension, notwithstanding its great simplicity, is so perfect that nails may be hammered into the wall carrying the apparatus without disturbing hearing in the least.

Finally, a box forming a continuation of the wall board carries a single receiver provided with two acoustic cords that are fixed to two lateral hooks, one of which (that to the right) serves as an automatic commutator. This same box contains likewise the induction bobbin employed first for telephonic transmissions by Mr. Elisha Gray, then by M. Berliner in 1877, and the use of which has been more lately popularized by Mr. Edison. Instead of employing a single receiver provided with a double acoustic tube, there may be

FIG. 2.—D'ARSONVAL AND BERT'S TELEPHONE.

used two of them, which will then be rendered movable. Such an arrangement increases the price and resistance of the apparatus without very marked advantages.

I have likewise devised another form of transmitter for portable purposes.

The microphone is then held in the hand, which forms the suspension. It consists essentially of a magnet with the poles bent into a circle. The four carbons, provided with their tin cylinders, are held opposite the poles by a vibrating wooden disk six centimeters in diameter. The external aspect of the apparatus is like that of a telephone, and it weighs less than 300 grammes.

The small model (Fig. 3), completed by a receiver, and a box containing the automatic commutator, the induction bobbin, and, if need be, the call bell, is very light. It gives just as good results as the large model, as far as clearness of transmission is concerned, and works in all positions. Moreover, as the microphone is movable, thanks to its connecting cord, it may be placed on a small standard, thus permitting of moving it about very conveniently on a desk without carrying along at the same time those numerous conductors with which a telephone apparatus is provided, such as bell and line wires, etc.

These apparatus have been studied for a long time in their smallest details by my manufacturers, Messrs. Paul de Branville and Ladislas Lenczewski. Experience long ago showed me that a good idea is not sufficient to produce a good apparatus, and that the role of the manufacturer is far from being as efficacious as appears to be believed by certain persons who have never had to struggle with the numerous difficulties that practice removes.

A third model is represented in Fig 2. Suspension is effected here by two widely distended spiral springs inclosed within the columns of the apparatus, which latter can be set upon a table.

The frame holding the microphone is movable around two pins carried by the center of the suspension springs, so as to receive all the inclinations possible. The receivers are movable and suspended from two hooks, one of which forms an automatic commutator.

It will be readily understood (being given the principle of regulating by magnetic attraction, which permits the apparatus to operate in all positions) that the arrangement of the microphone is variable according to its destination or the place that may be given it. I will make known before long two new arrangements, one for a central office and the other for theatric audition, and which are being tried now by the administration of post offices and telegraphs, and are giving excellent results.—*Dr. A d'Arsonval, in La Lumiere Electrique.*

SECONDARY BATTERY.

SOME experiments have recently been made with a form of secondary battery invented by Messrs. Liardet and Donnithorne, the main features of which, as stated by the inventors, are the intermixture of porous lead, deposited either by direct action by means of a galvanic current or by the action of spelter, with oxides and salts of lead such as may be produced from galena or other lead ore, as the acting substance of the plates to accumulate the current. This mixture is placed on very thin plates of pure lead, which serve as conductors, and is kept in position by porous plates. Great stress is laid upon the purity of the lead and lead compounds, as by this means the inventors seek to avoid local action and to increase the intensity and durability of the battery. The experimental set of cells consists of 50 elements, each of which has an area of one twelfth of a square foot, the weight of the set being 315 lb. The cells, having been charged with a dynamo, are reported to have given a current of 12 amperes with an electro-motive force of 95 volts; or, in other words, two have given a sufficient current for one small arc lamp or 25 incandescent lamps. Upon the occasion of our visit to the laboratory at No 38 Holborn viaduct, this battery supplied seven Edison incandescent lamps with a current. The inventors claim that they have produced a secondary battery or accumulator of half the weight, half the cost, and nearly twice the power of any other. So far as the laboratory experiments have gone, their results appear to be sufficient to encourage the inventors in proceeding with the work of practical development.

ELECTROMOTIVE FORCE.

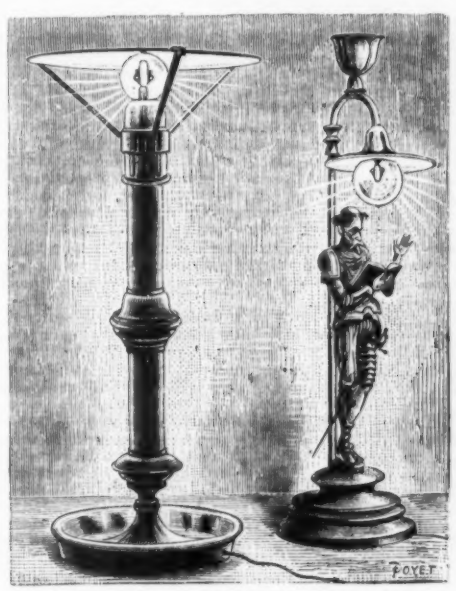
IT has been maintained by Exner that there is no known case of chemical action without the development of electricity, and also of the development of electricity without chemical action. Braun controverts this conclusion and repeats Exner's results. The latter employed a cell with zinc and platinum as elements, with iodine or bromine as the liquid. Notwithstanding the fact that iodine and bromine are elements and cannot therefore be electrolytes, this cell gives with an electrometer a difference of potential and in a closed circuit an electrical current. Exner believes that the cause of this current is to be sought in chemical action. According to his statement, wherever a chemical change results in a difference of potential, an electrical current results, whether the different metals are immersed in an electrolyte or not, as long as the liquid can conduct electricity. Braun endeavors to show that Exner reasons in a circle, since as soon as chemical action enters, the combination ceases to consist of elements, and it is necessary to show that the existing combinations are not conducting electrolytes. Braun shows that Exner did not take sufficient precautions to insure the purity of the iodine and bromine which were employed, and also to prevent the presence and disturbing influence of the aqueous vapor of the air. He concludes from the repetition of Exner's results that the conclusions of the latter are untenable. There are numerous cases in which we have a development of electricity without chemical action, and also strong chemical action without the development of electricity. A zinc and a copper plate in contact give a difference of potential; by their mutual attraction they can give out a certain amount of work. Their action can be represented by a piece of iron and an attracting permanent magnet; the removal of the iron requires work to be done, and the attraction of the iron by the magnet affords work. This action of a permanent magnet on iron, in the case of dynamo-machines, can play as great a function as the contact of Zn | Cu in a battery. Exner asserts that the electricity apparently due to contact is at the cost of the heat of oxidation. Braun says that this is equivalent to maintaining *a priori* that the permanent magnet affords heat at the expense of some process of oxidation.

Having criticised Exner's results, Braun shows how important the study of electromotive force is to the subject of thermal chemistry. A part of the matter in the series of difference of potential persists in that order in which the materials dispossess each other. While taking into account the heat of combination, and Berthelot's principle of maximum work, this ought not to happen; for instance, mercury is displaced by copper in Hg_2Cl_2, notwithstanding the greater heat of combination of mercury. The affinity of platinum and gold on the one side, and copper and silver on the other toward chlorine, stands in no relation to the thermal development (*Warmetonungen*). From purely *a priori* considerations, Braun thinks that it is possible that chemical changes are dependent upon the thermal condition; he, however, is convinced that the fitness for mechanical work of a chemical process determines the chemical change. If, for instance, the entire thermal development due to a process is zero, still exchanges can take place in which that combination results which is more stable in reference to heat. The direct chemical process which goes on without the development of electricity results in lowering the fitness for work of the entire matter. For Berthelot's principle, which can be entitled the principle of maximum development of heat, Braun substitutes the principle of maximum fitness for work. Berthelot's principle would then be a special case of the last, and would apply at the absolute zero of temperature, and the departure from his principle would be greater the nearer the temperature at which the investigation is conducted approaches to the dissociation temperature of the materials employed.—*Ann. der Physik und Chemie, No.* 12, 1882. *Am. Jour. Sciences.*

SMALL INCANDESCENT LAMPS.

SINCE the Exhibition of Electricity at Paris, during the continuance of which the incandescant lamps of Edison, Maxim, and Swan shone with all their brilliancy, the public has shown itself anxious to make use of this so agreeable a mode of lighting, which is so convenient of application. For a long time none of these lamps could be found anywhere, but at present they can be procured of any manufacturing electrician. This, unfortunately, does not mean that the incandescent lamp is as yet capable of solving the much sought problem of domestic electric lighting. The lamp exists, but a practicable source of electricity to supply it has not as yet been found.

So long as a distribution of electricity to dwellings has not been realized, or so long as inventors shall not have devised an entirely practicable pile, it will not prove possible to employ the incandescent lamp in the household. Such a mode



TROUVE'S SMALL INCANDESCENT LAMPS.

of lighting is at present advantageous only for those who can actuate dynamo electric machines by means of gas or steam motors.

However this may be, large numbers of physicists and amateurs are desirous of having incandescent lamps at their disposal, in order to operate them as objects of experiment or as an ornamental mode of lighting. To such we would make known the small chandeliers surmounted by incandescent lamps recently brought out by Mr. G. Trouve, and two styles of which are shown in the accompanying cut. In the first of these models, that to the left, the lamp is fixed beneath a reflecting shade, which advantageously distributes the light over the surface of a table. In the second, a lamp is suspended over a statuette, and beneath a socket serving as a support for an ordinary wax candle. Each of these small lamps may be actuated by three or four of Trouve's bichromate of potash pile elements; but, in such a case, the time during which the lamp will operate will certainly prove very limited, and a renewal of the liquid in the pile will not be a very convenient operation to perform in one's house. A few Plante accumulators, supplied by either Bunsen or Thomson piles, might, however, be employed by those who do not shrink before the troublesome manipulations of the laboratory. Such experiments, performed with a view to having an ornamental light, will assuredly tempt more than one amateur.—*La Nature.*

THE ELECTRIC ARC IN VAPOR OF SULPHURET OF CARBON.

JAMIN and Maneuvrier introduced a few drops of sulphuret of carbon into Geissler tubes, so as slightly to increase the pressure, and thus obtained a light of great brilliancy. On looking at it with smoked glass, they saw a brilliant arc resembling a horse-shoe or a capital Omega. The points of the two carbons appeared red and very brilliant: but the arc was of pale green, and as its light surpassed that of the carbons, the whole ball was illuminated with its tint as it would have been by a copper Bengal light. The brilliancy increased with the increasing tension of the vapor, until it became intolerable; but as the resistance increased at the same time, the arc was often extinguished, and it was necessary frequently to renew it by bringing the two carbons together. It is not likely that the light can be advantageously used, unless for light-houses or signals at a distance.—*Comptes Rendus*

PHOTOMETRIC MEASUREMENTS.*

By SIR WILLIAM THOMSON, F.R.S.

APPROXIMATIVE PHOTOMETRIC MEASUREMENTS OF SUN MOON, CLOUDY SKY, AND ELECTRIC AND OTHER ARTIFICIAL LIGHTS.

IN his opening remarks, the author referred to the identity of light and radiant heat, and spoke of them as but different modes in which the energy of vibration induced by the heat was conveyed to our consciousness. So far as our senses would allow us to judge, there was no difference. For example, a hot kettle, red hot iron, incandescent iron, platinum, or carbon, and the incandescence in the electric arc, all radiated energy in the same way, namely, in waves; and according as the energy was perceived by the sense of sight or that of touch, so was it spoken of as light or heat. Light was quite homogeneous in quality, in so far as its power of affecting the senses was concerned, and the undulatory theory of light was so well established that it was no longer to be questioned. When the period of vibration was longer than the one four-million-millionth of a second, the radiation could only be perceived by the sense of touch; but when it was shorter than one four-million-millionth of a second, and longer than one eight-hundred-million-millionth of a second, the radiation was perceived by the sense of sight. In the former case the vibrations give rise to the phenomenon of heat only, and in the latter to that of light. Pouillet, from a series of experiments made nearly fifty years ago on solar radiation, had deduced a value of the energy radiated by the sun as being equal in our units to about 86 foot pounds per second per square foot at the earth's surface, or about one horse power to every 6½ square feet of the earth's surface. From that we might estimate the probable value of the solar radiation at the surface of the sun. That body was, probably, an incandescent mass losing heat by radiation, and surrounded by an atmosphere of incandescent vapor, so that the radiant energy really came out from the sun as from a pit of luminous vapor. Suppose, however, the ideal radiating surface to be that of a globe of 440,000 miles radius, and the distance from the earth to the sun to be 93,000,000 miles, or the radius to be equal to, say, one two-hundredth of the distance; then the area at the earth's distance corresponding to one square foot at the sun's surface was equal to 40,000 square feet; therefore, the energy radiated by the sun was at the rate of 3,440,000 foot pounds per square foot, or, say, 7,000 horse power per square foot. The normal current passing through a Swan incandescent electric lamp giving a light of twenty standard candles was equal to 1·4 amperes, and the potential being from 40 to 45 volts, the energy working in the filament giving out the light was 61·6 ampere volts, or about one-twelfth of a horse power. Approximately, eight or nine Swan lamps, each of 20 candle power, were worked by the expenditure of one horse power; and since the area of the carbon filament of a Swan lamp was about one-ninth square inch, that was equal to about three-fourths of a horse power per square inch. Now the sun's radiation was at the rate of about 7,000 horse power per square foot, or, say, 50 horse power per square inch; therefore, the energy of the sun's radiation was at a rate about 67 times greater than that of a Swan lamp. The learned professor went on to suggest how an approximate measure of the probable temperature of the sun's surface might be obtained. He remarked that various estimates of the sun's temperature had been offered by physicists, ranging from one million degrees downward. In the year 1878 Rossetti reckoned that temperature to be about 9,000 degrees, but possibly the most probable value yet assigned was that of Dr. C. W. Siemens, about 3,000 degrees Centigrade. The probability of that value being more nearly correct than the enormous values of former years would be seen by comparing it with the following observed temperatures:

	Deg.
Incandescent melting platinum	1,800
Filament of Swan lamp, about or under	1,800
Incande-cent arc of 5,000 candles (Siemens)	2,300

The standard light to which photometric measurements were referred in this country was that obtained from what was known as a standard candle. Latterly, however, objection had been raised against its accuracy: indeed, it had been said that differences of as much as 14 per cent. had been found in the intensity of the light yielded by different standard candles, and that even serious differences in intensity had been observed in the light from different parts of the same candle in the course of its burning. The Carcel lamp, the standard in use in France, had been regarded as the only reliable standard. No doubt it was very accurate, but it should be remembered that its accuracy was greatly owing to the careful method and the laborious precautions taken to secure that accuracy. If something akin to the precautions applied to the Carcel lamp by Regnault and Dumas were applied to the production and use of the standard candle, there was little doubt but that sufficient accuracy for most practical purposes could also be obtained with it, probably as good results as were already obtained by the use of the Carcel lamp. At the Conference on Electric Units, which recently took place in Paris, a suggestion was made to use as a standard in photometric measurements the incandescence of melting platinum, and very interesting results and methods in connection with the proposal were presented to that meeting.

When dealing with approximate measurements, the author said that the most convenient method was certainly that of Rumford, by a comparison of shadows cast by the sources of light on a white surface. The necessary apparatus consisted only of a sheet of white paper, a small cylindrical body, such as a lead pencil, and a means of measuring distances. Ordinarily healthy eyes were usually quite consistent in estimating the depth of shadows, even when the shadows examined were of different colors, and, with a reasonable amount of care, an accuracy of about 2 or 3 per cent. might be obtained in photometric measurements by the method in question. The difference in the colors of the shadows was due, of course, to each shadow being illuminated by the other light. Arago had compared the luminous intensity of the sun with that of a candle, and estimated it to be equal to about 15,000 times that of the candle flame. The author had been informed by Helmholtz that Seidel had estimated the luminous intensity of the moon to be about equal to that of grayish basalt or sandstone. An experiment made in Glasgow on the 8th of the present month (subsequently to the paper being read), compared with an observation which the author made at York during the jubilee meeting of the British Association held in that city last year, has led him to conclude that the surface of the moon radiates something not enormously different from one-third of the light incident upon it. The observation on moonlight just referred to

* Abstract of paper communicated to the Philosophical Society of Glasgow.

showed that the moonlight at the time and place of the observation (at York, about midnight, in September, 1881, near the time of full moon) to be equal to that of a candle at 330 centimeters distance. The luminous intensity of a cloudy sky, one day about 1 A M., in York, during the meeting of the British Association last year, he found to be such that light from the sky through an aperture of one square inch area was equal to about one candle. The color of its shadow, compared with that of a candle, was deep buff yellow to azure blue, the former shadow being illuminated by the candle alone, and the latter by the light coming through the inch hole in the window shutter. The experiment of the 8th inst., already referred to, showed that at one o'clock in the afternoon of that day the sunlight reaching the author's house at the University of Glasgow was of such brilliancy that the amount of it coming through a pinhole in a sheet of paper, of 0·09 centimeter diameter, produced an illumination equal to that of 126 candles. By cutting a piece of paper of such a shape and size as just to eclipse the candle flame, and measuring the area of the piece of paper, he found the corresponding area of the flame to be about 2·7 square centimeters, or about 490 times the area of the pinhole; therefore, the intensity of the light from the sun's disk was (126×490) equal to 58,000 candles, or more than three times the value found by Arago for the intensity of the light from the sun's disk as compared with the flame of a candle.

SURFACE TEMPERATURES IN PARIS.

EDMOND and Henri Becquerel have presented to the French Academy their observations upon the temperatures of the air and earth during the year 1880. They find that at the upper surface of the ground, when covered with snow, the temperature was maintained almost constantly in the neighborhood of —1° C. and did not fall below —1·5°, although the temperature of the air as well as that of the upper surface of the snow varied from —15° to 0°. The diurnal variations of temperature at the surface of the soil were perceptible under a mass of snow of 0·25 meter thickness (9·84 inches), but they never exceed a few tenths of a degree; moreover, the differences in the observed temperatures at different depths in the snow varied nearly in proportion to the depth. These results show that a bed of snow, when the temperature is below 0°C., has a feeble conductivity, and behaves like a conducting body traversed by a calorific wave. Under a surface which is covered by turf the variations are much more feeble than under a surface of gravel or loam. The network of rootlets constitutes an almost complete non-conductor. Each bed of soil is submitted to the influence of two calorific effects; one due to the variations of external temperature, the other to the action of the deep layers which tend to produce a constant temperature. The amplitude of thermometric oscillation which results from these complex effects when there is any disturbing influence, such as an infiltration of water, varies inversely with the depth of the bed.—*Comptes Rendus.*

APPARENT RADIATION OF COLD.

IN an article entitled "Heat" in the SUPPLEMENT of Jan. 20th, p. 5875, the writer seems to experience great difficulty in reconciling the apparent radiation of cold, in the well-known experiment with concave mirrors, with the theory of exchanges. While the usual brief explanation of the depression of the thermometer in the focus of one concave mirror by a piece of ice placed in the focus of the opposite similar mirror, based on the inequality of heat exchanged between the two bodies, is by many accepted without further reflection, others, like the writer of the article alluded to, on closer study find themselves unable to account for the phenomenon in this way. All bodies radiate heat, colder ones only less than warmer ones. Before the ice is placed in the focus of one mirror, the thermometer in the focus of the other is radiating heat at a rate dependent solely on its temperature. The placing of the ice in the focus of the opposite mirror in no way affects this rate of radiation, and consequent loss of heat, but, on the contrary, it radiates heat, which is reflected from the mirrors, and is finally converged upon the thermometer, and should, and actually does, in a measure replace the heat lost by radiation by the thermometer; and yet the thermometer not only does not rise with this increment, but on the contrary falls; and if the explanation could not be rendered more complete, we would be forced, as the writer alluded to has been, to reject the theory of exchanges or admit radiation of cold. Without considering in detail the various statements of the article, I think it can be safely asserted that any case of apparent radiation of cold, if carefully examined, will be found to be a case of substitution of rays of less intensity for those *previously received* by a body, while the rate of radiation of the body, and consequent loss of heat dependent upon its temperature, remains unchanged; and if the body is a thermometer, it will fall. To illustrate: The bulb of a thermometer placed in a room is in a state of exchange with all surrounding objects. If it manifests a constant temperature, it is because it receives from these surrounding objects just as much as it loses by radiation, its *rate of radiation* being conditioned solely by its temperature, but its *rate of cooling or heating* by the temperature of the surrounding objects or inclosure as well. If a body colder than the inclosure, as a piece of ice, is now introduced near the thermometer, heat rays, emanating from different points of the inclosure, will be obstructed in their passage by the ice, while the latter will send its own feebler radiations to the thermometer, and this difference in intensity in the rays received by the thermometer, while those emitted by it remain the same, occasions a diminution of temperature and consequent fall of the thermometer. The principle remains the same when one or two mirrors are employed. If a concave mirror is placed so that the thermometer shall be in its principal focus, rays of heat coming from some points of the inclosure will strike upon the back of the mirror, and be cut off from the thermometer; but for every ray so cut off another ray from the opposite side of the inclosure, striking the mirror parallel to its principal axis, and which did not reach the thermometer before, will be substituted.

It is assumed that the inclosure is of uniform temperature, and that the thermometer has also acquired the same temperature. If a second mirror, facing the first, is simply introduced, without placing any body in its focus, while it will cut off the rays that were substituted, as already explained, for those cut off by the first mirror, it will also replace them by others, not previously received by the thermometer, coming from other points of the inclosure, which pass through its focus, and are consequently reflected parallel to its axis, and consequently converged by the first mirror upon the thermometer. Such rays may be represented as coming from points at the top or bottom of the inclosure. If now a colder body than the inclosure is placed in the focus of the second mirror, it will obstruct these rays that previously passed through the focus and were reflected to the thermometer, and in-tead the less intense rays, radiated from the cold body to the mirror, will be reflected to the thermometer, which, continuing to radiate at its previous rate, and now receiving less in exchange, will show a loss of heat, or diminution of temperature. The cold body placed in the focus of the second mirror thus as effectually cuts off rays from the inclosure that would reach the thermometer, as the piece of ice in the experiment first described without mirrors; and, as in every case, such an obstructing body furnishes rays of its own in place of those cut off. If it is hotter than the inclosure, it will be readily understood that the thermometer will gain by its presence.

C. F. H.

Carlisle, Pa.

PRODUCTION OF LOW TEMPERATURES.

L. CAILLETET gives an account of some of his experiments on the use of liquefied gas, particularly ethylene, for the production of low temperatures.

Ethylene is liquefied at + 1° by a pressure of 45 atmospheres; its critical point is in the neighborhood of + 18°, while that of carbon dioxide corresponds to + 31°. These properties led Cailletet to determine whether a more intense cold could not be produced by liquefied ethylene than by liquefied nitrous oxide. In order to compare these temperatures, he made use of a thermometer with an arbitrary scale, filled with carbon bisulphide. When plunged in liquefied ethylene, this thermometer indicated a temperature corresponding closely to —105°, far below that caused by liquid nitrous oxide, which is —88°.

The ethylene used in the experiments was prepared in the usual way by heating a mixture of alcohol and concentrated sulphuric acid, and after being purified by passing through cold sulphuric acid and caustic potash solution, to remove the ether and sulphur dioxide, was compressed by means of a powerful pump, designed by M. Cailletet, in bottles previously tested by a pressure of several hundred atmospheres. By this apparatus, ethylene was readily liquefied, but its employment in the liquid state presented serious difficulties, for when the attempt was made to draw off the liquid ethylene from the bottle in the ordinary way, as with nitrous oxide, no trace of liquid was obtained, and it was therefore necessary to devise a special apparatus in order to make use of it as a source of cold.

When liquid ethylene is allowed to escape from the receiver in such a manner that the liquid drops strike directly against the apparatus to be cooled, there is no great loss of the liquid, and the temperature is further lowered by the expansion of the gas not liquefied. These conditions are best realized by fixing the receiver containing the cooled liquid ethylene in an iron support, and attaching to the orifice of the receiver, directed downward, a tube of glass of 5 or 6 mm. diameter, bent at a right angle. When the stop-cock is opened, the compressed gas and the liquid are projected with moderate velocity against the apparatus to be cooled. Liquefied ethylene, by evaporation at the atmospheric pressure, can then produce a cold more intense than has hitherto been realized by any other means; it possesses the advantage, moreover, of remaining liquid and transparent at temperatures at which nitrous oxide and carbon dioxide become solid and opaque.

In experimenting upon liquefaction of oxygen with the aid of liquid ethylene, M. Cailletet has obtained interesting results differing entirely from those previously observed by him when nitrous oxide was made use of as a source of cold. In the latter case, when the tension of the compressed oxygen cooled to —88° by means of liquid nitrous oxide was suddenly diminished by allowing a portion of it to escape, there was produced a light cloud which disappeared immediately on stopping the escape of the gas; when, however, the oxygen was cooled to at least —105° by means of liquid ethylene, there was noticed an appearance of tumultuous ebullition which lasted for quite an appreciable time, and which resembled the sudden projection of a liquid into the tube.

M. Cailletet hopes to produce still lower temperatures by condensing, by means of the apparatus now at his disposal, gases more difficultly liquefiable than ethylene.—*Amer. Chem. Jour.*

PATENT (CONCENTRATED) ESSENTIAL OILS.

ALREADY Liebig, years ago, enunciated his belief that oxygen is so all-essential to the development of the odor of plants that it might be said to be the bearer of the aroma. He based his opinion on the fact that the so-called camphenes (terpenes), considered to consist only of carbon and hydrogen (as oils of lemon, neroli, turpentine, juniper, savin, etc.), when distilled over freshly burnt lime in an apparatus exhausted of air or filled with carbonic acid gas, were entirely deprived of odor, which, however, returned when the oils became oxidized to a certain extent. Although the industrial application of this fact would seem to be but a natural sequence, it was reserved for Dr. Gustav Haensel, in Pirna (Germany), to carry the idea out successfully on the large scale, which occurred as late as 1875, and samples of several of his concentrated oils were exhibited at the "Centennial" in Philadelphia.

The so-called oxygenated oils (chiefly derived from the natural orders Umbelliferæ, Labiatæ, Lauraceæ, and Compositæ) consist of two component parts, separable by fractional distillation. The more volatile part is a camphene, and possesses so little odor that it can be and has been used to adulterate other essential oils. The heavier compound, containing oxygen, is the sole bearer of the peculiar aroma.

These oils are not only purer and more agreeable in both odor and taste, but are much stronger, and are very easily soluble in weak alcohol, perfectly transparent.

Even of the so-called camphenes Dr. Haensel has succeeded, by a somewhat more complicated process, in producing concentrations of a remarkable strength and purity of odor, and as easily dissolved.

Manufacturers of liqueurs and cordials will find by the use of these patent oils a great saving of time and trouble, inasmuch as no clarification is necessary, provided that the body is perfectly clear.

For keeping, these concentrated oils require the same precautions as to light and temperature as the ordinary oils, and an addition of one-half per cent. of absolute alcohol serves to keep them better.

Dr Haensel gives the following strength as compared with ordinary essential oils: Angelica, 30 times stronger: Anise, 2 times; Bergamot, 2½ times; Calamus, 10 times; Cassia, 2 times; Lemon, 30 times; Coriander, 6 times: Fennel 2 times; Caraway, 2½ times; Spearmint, 2 times; Lavender, 2½ times; Cloves, 2 times; Peppermint, 2 times; Orange peel, 30 times; Sassafras, 2 times; Thyme, 5 times; which means that for instance 1 fl. drachm of concentrated oil of Angelica will flavor a barrel of diluted alcohol as strongly as 30 fl. drachms of the ordinary oil of Angelica.

These oils form clear solutions with 60 parts of 70 per cent. alcohol, and mix clear with 80 per cent. alcohol in all proportions.—*Stearn's New Idea.*

PLAGUES AND PESTILENCES.

AT a recent meeting of the members of the Statistical Society, London, Mr. Cornelius Walford, barrister-at-law, read a paper on the "Chronology of Plagues and Pestilences, as Affecting Human Animals and Vegetable Life." The causes, as collected from all sources, where specified, as judgments, abnormal condition of the air, arising from the introduction of extraneous matter or gases from space, such as meteorites, cosmic dust, dust and sulphurous gases ejected from active volcanoes, or released by earthquakes, noxious gases from decaying vegetable matter left after the subsidence of floods, effluvia from putrefying bodies uninterred during sieges and after battles, putrefying animal or other matter affecting the water supply, and exhalations from the soil. As predisposing causes were given want of food, change of climate in armies on the march, fatigue, fear, excessive luxury or debauchery, crowded and unhealthy dwellings, especially during wars; while as causes inducing famine, droughts, floods, and plagues of insects were specified. The view that plagues and pestilences are judgments dated from the earliest pagan times, and students of the classics will remember the plague supposed to have been caused in Attica by the gods as a punishment for the slaughter of a sacred bear; that in Thessaly by Apollo on account of disrespect shown; a plague at Sicyon caused by Apollo and Artemis for the same reason; and the plague in Samaria given in Josephus as the punishment of idolatry. In the "Iliad," Homer describes the plague which prostrated the Greek camp from the wrath of Apollo at an insult offered to Chryses, his high priest. A similar plague was inflicted by Apollo at Corinn, on account of Hyppolatus killing his prophet. Delphi, we are told, suffered a plague and famine as punishment for the ill-treatment of Æsop. In Rome a dreadful plague raged, which the Sibylline books proved to have been caused by the incontinence of a vestal virgin, who strangled herself to avoid being buried alive. Scripture records recount five instances of plagues inflicted by God as direct punishment for discontent and murmurings among His chosen people.

Coming to profane history, we learn, A.D. 665, over-population caused a dearth of food in Ireland, which prepared the people for a severe infliction of plague, which had broken out in England the year before. Rufini tells us that the joy of the English at the victory of Cressy in 1347 and the surrender of Calais the year after induced such unbridled excess and debauchery that God, not permitting these disorders to go long unpunished, inflicted the plague, which, after traversing Asia and Europe, raged with such fury in London that 50,000 persons were buried in the churchyard of the Charterhouse alone. The belief in these direct judgments remained down to very modern times.

That earthquakes are the more potent of the terrestrial causes of plagues and pestilences had the support of Scripture authority, notably in the 14th chapter of Zechariah and the 17th of St. Luke, verse 2. Thucydides mentions plague, associated with serious earthquakes, preventing the annual invasion of Attica, and the famous Black Death of 1348 was preceded by fearful earthquakes and fiery meteors of portentous aspect. A violent earthquake in Central Germany heralded the third appearance of the sweating sickness and epidemic encephalitis in 1517, and of that epidemic in Holland at the same time, which physicians now believe to have been diphtheria. The great eruption of Mount Hecla in 1783, when a river of lava twelve miles wide flowed in six weeks a distance of sixty miles into the sea, drying up twelve rivers and destroying twenty-one villages, was followed by diseases of a most peculiar and inveterate kind. In the same year there were most destructive earthquakes in Italy and Messina, and terrible pestilences prevailed in Central Europe, due, as is supposed, mainly to the vapors or exhalations.

Great destruction of life has been attributed at different times to mephitic vapors not due to earthquakes. In the year 140 B.C. the Roman army in Algeria are said to have fallen victims to mephitic vapors generated by themselves for the destruction of the inhabitants, and in A.D. 168 a plague at Rome, preceded by a still more destructive plague in Asia, was supposed to have had its origin in foul airs from a small box which a Roman soldier had opened at the capture of Selucia.

Our own annals tell of a marvelous visitation of rain and thunder in 1223, by which the congregation of the church of Barnwell, near Cambridge, were sorely tried. "Such flashes of lightning entered the church that each man thought it had been set on fire; and such a filthie stench arose withal that manie of the company fell sick thereof and hardly escaped death." The plague of 1345–49 which is said to have begun in China, "from the vapors proceeding from a certain fiery body which fell from the atmosphere, or was eructated from the earth," caused awful mortality. In Florence, 100,000 people died; in London, 59,000 are said to have died in a single week; while 100,000 perished in Venice, 90,000 in Lubeck, and 200,000 in Spain.

One of the modern theories ascribes pestilence to cosmic dust composed of iron, nickel, cobalt, and other substances. This receives some support from the Jewish writer Philo, who in A.D. 93 describes a "loimic" pestilence arising from clouds of dust, which produced severe and intractable ulceration of the skin both of men and animals. In A.D. 593, during a pestilence in Rome, the air was charged with a mist or cosmic dust which induced violent sneezing, which gave rise to the expression "*Dominus tecum*" to a sneezer, a practice not yet extinct.

A haze or "dry fog" has been frequently noted as accompanying cholera visitations. Such a haze, which was of a pale blue shade, and possessed of peculiar drying properties, and of a marked and indescribable odor, was very prevalent in the year of convulsions just a century ago, and its dispersion in 1783 was attended with violent thunderstorms. It is thought that this haze may be associated with the powerful agents which seem to pervade the air after volcanic and earthquake eruptions, and on scientific grounds it seems clear that some diseases may be so occasioned.

During plagues and pestilences popular superstition has frequently suggested poisoning the waters as the cause. Different sects were thus led to accuse each other, and this and other malpractices, and the mortality arising from disease was swelled by slaughter. At Mentz 12,000 Jews fell victims to the populace, on suspicion of having poisoned the wells of the city. In Milan, in 1680, when a severe visitation of plague occurred, there was a popular belief that the disease was propagated by people who anointed the walls of the houses with a poison fatal to all who touched it, and

many unfortunates who were suspected lost their lives; while the house of a barber, named Mora, who was accused of preparing the poison, was pulled down, and a column, known as the "Column of Infamy," was erected on the site, where it remained until 1778.

Drought, both in ancient and modern times, has been too intimately connected with diseases of unusual severity to leave much doubt of their being in some way connected. Pestilence has been caused not unfrequently by the decaying bodies of locusts and animals perishing during an epizootic visitation, as well as by decaying vegetable substances.

Under all the other heads some very curious and interesting facts were collected and stated, and a complete enumeration was given of all the authenticated cases of plagues that have afflicted humanity, and of the legislative means taken for mitigating their effect; the author suggesting, at the conclusion of his paper, that there still remained to be treated, the "Periodicity of Plague Visitations," the "Spontaneous Origin of Disease," and "Pestilential Cyclones."

COATING PILLS WITH GELATINE.*

By CLAY W. HOLMES.

MUCH has been written on the preparation of gelatine-coated pills, and various contrivances have been made and offered to pharmacists, protected by patents, and at an exorbitant price, so that few attempt the extemporaneous preparation of coated pills. Like other manipulations in the laboratory, the coating of pills requires some experience, yet a reasonable amount of practice and patience will enable any pharmacist to devise means by which, at a minimum outlay, he can make a pill equal in appearance to those offered by the large manufacturers. It is the writer's desire to lay out the practical points in such a manner that any one can proceed intelligently, and without difficulty. The first point which presents itself is the pill to be coated. Pills composed entirely of dry powders offer little difficulty. Those containing a large proportion of extracts may occasion trouble. Much depends upon the excipient employed. Simple syrup is the best whenever it will make the mass sufficiently adhesive. In case this fails, confection of rose, or ext. gentian may be employed. Glycerine should never be used. If the mass is too soft, owing to the presence of a large portion of extract, stiffen it with sugar of milk or powdered gum arabic. The mass having been carefully prepared, the pills may be made either oval or spherical. The writer prefers the oval.

In making granules of arsenious acid, strychnia, or other active remedies requiring minute doses, add enough sugar of milk to give the desired size, and make the mass with simple syrup. The pill being properly made, the next point is the apparatus for coating. The writer has made use of a round tin cup, about three (3) inches in diameter, in appearance like an ordinary blacking-box cover. The needles used were "No. 1 sharps," ordinary make. A thin layer of paste or plaster of Paris and water is poured into each cup, and the needles set in the plaster. Each cup will hold twenty-five (25) needles. Place one in the center, and around that run two circles—the first, half the distance between the center and the edge of the cup; this circle to contain eight (8) needles. The outer circle, within one-eighth (1-8) of an inch of the edge; this circle contains sixteen (16) needles. If the distances are properly divided, the needles will be far enough apart to hold the largest pill without fear of contact. After the plaster has set make more paste, thin enough to pour, then fill the cup. Let it stand until the plaster is firm, and then the cup is ready for use. The pills are readily stuck on the needles by hand, transfixing them as lightly as possible. The pill is now ready for coating. The coating solution is prepared as follows:

R. Gelatine, French (gold label)	℥iv.
Gum arabic	℥j.
Sugar	℥j.
Water	q. s.

Dissolve the gum arabic and sugar in eight (8) ounces of hot water in a capsule by means of a water-bath. Then add the gelatine and stir it until dissolved. Should the water have evaporated to such an extent that the solution is apparently too thick, add water gradually until it has the consistency of hot syrup. Continue the heat until a pellicle forms on the surface, then pour into a cold dish. A sixteen (16) ounce porcelain-covered casserole, with handle and lip, is a convenient dish to use, or a tin vessel may be made use of, a pint cup with a lip being about the size. Let the solution stand until the temperature is somewhat lowered, stir up the solution to break pellicle, and then dip the pills into the solution, lowering carefully until completely immersed. Pull them out slowly, that the surplus gelatine may run off, and then bring the needles to a horizontal position and rotate slowly for half a minute, when the cup may be set down. As soon as the coating is sufficiently set to prevent adhering to the fingers when touched, the pills are ready to come off.

Take an alcohol lamp with a small flame, and let the needle strike the flame about ⅛ inch from the pill. As soon as the needle is heated, the gelatine begins to swell. Twist the pill off carefully, before the needle gets sufficiently hot to soften the pill, and with the finger stop the hole while the gelatine is hot. The pill is then ready to dispense.

If it is intended to keep the pills in stock, they should be exposed to the air for a few hours before bottling. After the process is finished, pour the coating solution into a wide-mouth pint bottle, and when cold pour on sufficient alcohol to make a strata ½ inch deep on the surface of the gelatine and cork tightly. In this way the gelatine will keep for any length of time. When necessary to use, again pour off the alcohol into a smaller bottle (kept ready for that purpose), place the gelatine bottle in a ½ gallon tin measure, putting a large piece of cork in the bottom to protect the bottle from direct heat, fill the measure nearly to the neck of the bottle with cold water, and put over the gas flame or on the stove. Continue the heat until the gelatine is thoroughly liquefied, and then pour into the coating-dish previously used. Place the empty bottle in the measure to keep it hot. As few or as many pills as you wish may be coated, and then the solution at once returned to the bottle. After the pills have been removed from the needles, the next consideration is to restore the needles to their original condition.

A tin pan, or any convenient vessel having a flat bottom, is filled to the depth of an inch with hot water, and the cup is set in, the points being placed downward, the water not being deep enough to reach the cup. As soon as the gelatine is soft take the cup out, and with a small notched stick push the gelatine bulbs off, and then plunge the points into a bag of coarse emery a few times. This polishes the needles, and they are then laid aside until wanted again.

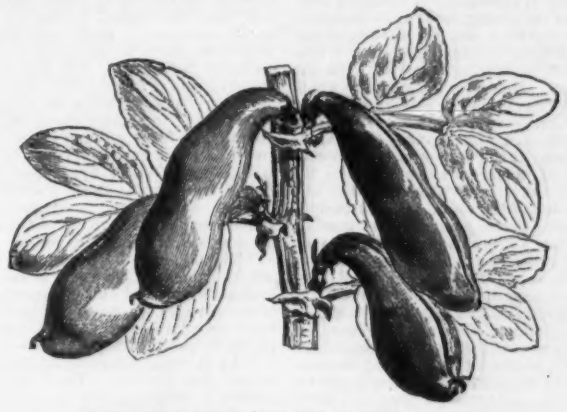
The only points of difficulty in the process, to the average pharmacist, will be the making of the pill and the proper consistence of the coating solution. Both must be learned by experience. If the coating is too thin on the pill, or does not cover it perfectly, evaporate the solution somewhat. Should it form too thick a coat, add a little hot water, and stir well. A pellicle forms rapidly, and it is necessary to stir frequently to prevent the pellicle from adhering to the pills as they are drawn out of the solution.

The difficulty in regard to the consistence of the pill shows itself in the bursting of the coating, and the exudation of the mass, when too soft, as is often the case in pills made largely from solid extracts. To remedy this, the mass must be made harder by the addition of gum arabic, or some other inert powder. Like all other labors in the laboratory, this process is open to the prospect of failure unless some degree of patience is exercised. The general working points are simple, the process does not require any elaborate machinery or contrivances, which might open a legal question as to "rights of protection," and any one can, without fear of trouble, prepare for himself the simple apparatus described in this paper, and make any pills for which he may have a demand.

* From the Proceedings of the New York State Pharmaceutical Association, 1882.

BROAD BEANS.

MESSRS. Vilmorin write, in reference to my remarks on Broad Beans, that the illustration of the improved Windsor given is identical with their Julienne Bean, a useful variety, and superior to the Improved Windsor, for the accompanying representation of which I am indebted to that firm.—*J. Muir, in The Garden.*



IMPROVED WINDSOR BEAN (VILMORIN).

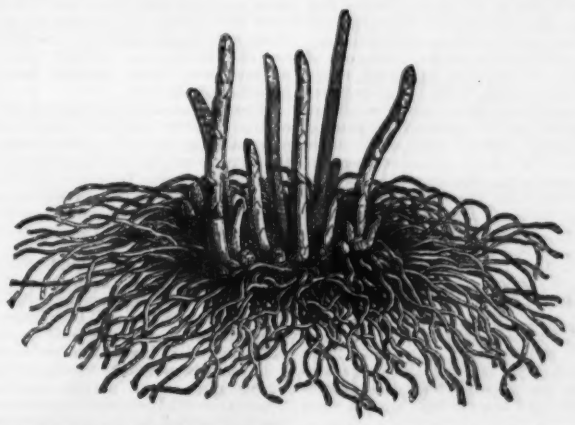
ASPARAGUS ON THE FRENCH SYSTEM.

HAVING for some years cultivated asparagus on this system, a few practical hints and observations in reference therero may not be without interest. Some who prefer green asparagus to that which is blanched condemn the French method of culture, forgetting that by it green asparagus can be had quite as well as by the old fashioned bed plan, by simply leaving the ground level instead of raising mounds of soil over the plants. Where fine asparagus is desired, either green or white, the French mode of planting in single rows, four feet asunder, and from two and a half to three feet apart in the rows, must be infinitely superior to crowding three rows into a bed four feet wide. To those who have not already tried this plan and are thinking of doing so, now is a good time to begin. Choose an open sunny piece of ground and well manure it; then bastard trench, working part of the manure into the lower spit; after the trenching is finished, no more is needed till planting time; then mark out the ground as for celery, with this difference—the trenches need not be more than three inches deep. The ridge of soil can be cropped with lettuces, French beans, or any small crop until the asparagus is thoroughly established, when there will be no room for other crops. In order to have the right kind of plants for planting, the best way is to grow sufficient to enable one to select the most promising, as a good percentage of fine heads depends upon the right kind of plant being chosen in the first instance, *i. e.*, in the one year old stage. When the young plants have made growths two inches in length, the last week in March or early in April then is *the time to take them* up for planting, choosing those that have one or two stout shoots in preference to those that have a greater quantity of weaker growths. My impression is that the plants which show greatest vigor in their early stages maintain it throughout their whole existence, and what is of great importance to the cultivator is the fact that such plants bear but few if any seeds. I may mention that in the second plantation which we planted here this selection was rigorously carried out, and the result is that a large proportion of the plants employed are berryless or seedless, and consequently grow with greater vigor. Before I was aware of this fact, thinking to procure seed from some of the finest heads, I allowed them to grow away a month before we finished cutting in order that they might not be fertilized with pollen from weaker growths, all the others being cut until the end of the season; but what seemed strange to me at the time was the fact that not one of these stout shoots that were left produced a single seed.

Blindness, a frequent cause of failure on the bed system is not entirely absent from the single row plan. It is caused in this way: Some plants start earlier into growth than others, and as all are cut till a given season, it necessarily follows that the early plants are cut more severely than the later ones, until not a bud is left for growth the following year. Such plants, therefore, are what are termed blind, and die. Single rows, however, present greater facility for avoiding failures of this kind than the bed plan, as by placing a stick down near the weak and early plants the gatherer is enabled to spare them; moreover, if a plant dies out entirely, it is an easy matter to replace it. Another advantage belonging to this plan is the following: If the weather should prove hot and dry during the cutting season, a good thick mulching can be applied between the rows, followed by a heavy watering, which will keep the plants in active growth during the hottest weather, while otherwise a check would occur from drought. I attach the greatest importance to this mulching. From the annexed representation it will be seen that the roots take a lateral direction, thus gaining complete possession of the four-foot space between the rows, a fact which shows that the manure and water are applied to the very place from which the plants derive their supplies, and where, but for the mulching, they would suffer most from exposure to bright sunshine; moreover, the hotter the weather the more rapidly will the heads come through, provided the ground is kept moist. It has been recommended to remove the mounds of soil from the crowns in the autumn and to give a top dressing of manure. We formerly adopted this plan, but since the winter of 1879 we have discontinued it, having found that our plants suffered severely from the hard frosts of that winter, owing no doubt to the total absence of snow when the frosts were most intense. We find it now a safer plan to manure between the rows in the autumn, leaving the uncovering and manuring of the crowns until the sharpest of the winter is over.

The best manures are moderate dressings of salt, seaweed if obtainable, bone dust, and burnt vegetable refuse, all excellent fertilizers. We also use Horsfield's garden manure, which is largely composed of dissolved bones. A top dressing of this is given before the mulching, and is evidently a valuable aid in the production of fine asparagus. Formerly our asparagus on the old system was of the poorest description, being about the size of stout wheat straws, but under the French plan fifty heads often weigh upward of nine pounds, and some of the stems of this last season measured nine feet in length.

WM. ALLAN.



WELL DEVELOPED STOOL OF ASPARAGUS, THE RESULT OF ALLOWING AMPLE SPACE.

NOTES ON ASPARAGUS.

THIS, the most delicious of all vegetables, is more generally cultivated now than it was a number of years ago. At one time it was almost exclusively confined to the gardens of the wealthy, but now every one fortunate enough to have a garden has an asparagus bed. Here we have half an acre or more devoted to it, and this extent will probably be doubled in the spring, as none of our vegetables are so useful or acceptable from November until June as asparagus. Low, damp ground or a stiff soil is ruinous to it, and those who attempt its culture under such conditions will never succeed. If the roots should live, it will only be for a short time; they will dwindle away and perish here and there, or wholly before they have yielded a satisfactory return for the outlay connected with their culture. I have planted asparagus on

very stiff, half clayey soil, in soil loose on the surface, but retentive underneath, and in places where it was light throughout, and in the latter it succeeded as well as one could desire it to do, but under the other circumstances just named it was never satisfactory. Now we plant nowhere but in the lightest of soil, and never experience any failure. As is well known, the roots of asparagus are soft and fleshy, and not at all suited to run into or exist in clay or stiff soil, but they are thoroughly at home in porous material. It is an old-fashioned plan to put a quantity of branches under an asparagus bed where the soil is heavy, but it is by no means a good way, as the boughs soon rot and make the ground beneath worse than if they had never been there. Making the beds high and dry, with a wide, deep trench between each, is another common mode of procedure, but it has nothing to recommend it, and may be condemned as a waste of ground, resulting in inferior produce. In short, I dislike asparagus beds of any kind, and would never form them or advise any one else to do so.

The best way of growing this esculent is to plant it row after row on level ground, and allow plenty of space between the plants. Having the roots only one foot or so from each other, or crowding them together in any form, will never result in fine-sized produce. I have seen asparagus beds, the summer growths of which formed a perfect forest, a mass of stems and weeds. Such plantations could not be expected to yield superior produce. Under the improved system of culture mainly made known through *The Garden*, plenty of space is allowed both crowns and roots. The tops are never crowded, and therefore there is abundance of room for ordinary routine operations, and the young heads come up strong and succulent. For years we have not planted any of our asparagus roots closer than three feet apart each way, and as every alternate root is lifted for forcing, many of them are five feet and six feet asunder. Referring to the soil in which these are growing, I may remark that it is very light, but previous to planting it was all trenched up to the depth of twenty inches. As this went on, a large quantity of all kinds of vegetable refuse was placed at the bottom of each trench; afterward a slight coating of manure was forked into the surface, and when finished the ground was altogether in a suitable state for the reception of the roots. One piece done and planted in this way half a dozen years ago has gone on improving annually, and now I would not exchange my asparagus plantation for any other I have seen.

In preparing quarters for *subsequent plantations*, all have been treated in the way just described. Where there is no choice of soil, all being heavy, I would begin preparing for asparagus by trenching and adding the refuse as has just been suggested, and a large quantity of sand or rough grit should be forked well into it previous to adding any manure. Ashes, which are sometimes used to lighten heavy soil for certain crops, should not be used for asparagus, as I never found the roots do well where they came in contact with them. Wood ashes are not so objectionable, and if mixed with a quantity of general charred refuse, they are very acceptable. Among artificial manures, ground bones are the best for asparagus, and horse droppings, especially in the case of heavy soils, are better than cow manure. When the soil, however, is properly prepared at first, no extra additions are required for some years, and then they should be chiefly applied as top dressings, unless the roots are far enough apart to allow of some dwarf crop being grown between the rows, when it may be necessary to dig or fork in a quantity of manure before sowing or planting the catch crop.

Now is the time to prepare for *new plantations* to be made in the spring. Trenching should be seen to without delay. An open, sunny, dry spot is not too good a situation for asparagus; in fact, nothing is too good for it, and extra attention in respect to it will not be thrown away. In order to keep up an annual supply of roots for forcing or for any other purpose, there is no better plan than sowing an ounce or two of seed every spring. This may be done in any corner, as the roots will be transferred to properly prepared situations when one year old. We sow every April, and in the following April the plants from this sowing are planted in good soil about two feet apart, and next season they are sometimes all transplanted again at distances of three feet and four feet apart, or every other one only is taken to fresh quarters. Asparagus may be transplanted at almost any age with the greatest success provided it is not kept long out of the soil; but when the roots are allowed to dry up, it is a long time before they get over the check they thus receive. It is for this reason we always prefer home raised seedlings to bought in plants; the former can be taken up and planted again before feeling the change, but the latter often suffer much in transit. Lately we lifted many scores of roots for forcing, as it is about this season we take up all that we require to keep us going throughout the winter. They are lifted immediately the stems wither. The latter are cut off, and to keep the roots comfortable until wanted for forcing, they are spread out in cold frames and covered over with some old mats or hay. Lifting them in this way may do them no good, but at the same time it does them no harm; our main object is convenience, as should frost or snow occur, it is a difficult matter to get them dug up, but when stored away in frames they are ready at all times. As soon as all the roots we want for forcing have been lifted, those remaining are mulched with juicy manure, and it is astonishing how well they sprout up in spring when this protection is removed and forked into the surface around each crown.

Forcing asparagus is a favorite practice with us. We have been cutting a dish of it almost every other day since the end of October, and will go on doing so for some months yet to come, but there is no secret in forcing thus early; a very great amount of heat is not even necessary. It is, however, most desirable that the roots should be well developed, and above all well matured, and the only way to insure this in such seasons as these, or indeed at all times, is to avoid the old system of crowding the roots and growths together and grow them so wide apart that each root may be regarded as an isolated plant and not a matted bed. Quill-like growths are the rule as regards the latter, but substantial heads, one inch or more in diameter, are the kind we are accustomed to cut from plants set widely apart.

CAMBRIAN.

REACTIONS OF THE BILE PIGMENTS.—*E. Caprasica.*—If 3 parts of bromine dissolved in 100 parts of alcohol are added by drops to a solution of bilirubine in chloroform or ether, the liquid becomes first emerald-green, then blue, violet, red, yellow, and finally colorless. The action of chloric and iodic acid is similar. The solutions of the yellow cells of the chloroides and retina, of the yolk pigment, and the corpora lutea, are decolorized at once without a trace of green coloration.

ORANGE TREE SCALE.

MR. E. TIDMARSH, Curator Botanic Gardens, Grahamstown, South Africa, writes the following to the *Journal*, of that city:

"This destructive pest, of which at least two species find a home on the branches and foliage of the citrus family, injures the trees in various ways, directly and indirectly. The most direct damage is caused by the extraction of the sap of the tree. In addition to this, the 'scales' at length become so numerous as to cover the smaller branches with a coating composed of living and dead insects, and thus exclude light and air from the bark. If a badly infected tree is closely inspected in a good light, small shining specks will be seen scattered about the upper surface of the leaves. These bright specks are tiny drops of a sweet liquid, excreted by the scale, and commonly known as 'honey-dew.' This sweet matter is one link in the chain of indirect damage to the trees, as it forms a fertile soil for the growth of a black fungus, which at length spreads over the leaves in a layer of soot-like matter of about the same thickness as the leaf itself, with which, however, it has no intimate connection, as may be seen on rubbing the leaf between the finger and thumb, thus removing the fungus from its surface, and showing a bright green leaf apparently uninjured. This is no doubt in great measure due to the fact that the honey-dew is deposited on the upper surface of the leaf only; the under side is therefore free from the black fungus, and is thus able to perform its functions. The 'scale' does not stand alone in sucking out the sap of plants and converting it into honey-dew, since the insect known to gardeners as 'green fly' (*aphis*) produces it more copiously than the scale (*coccus*). This latter insect is not found in quantity on the quite young shoots of the orange. The reason of this is not difficult to discover, and is found in the fact that the rate of growth of the shoots is rapid, while the progress of the scale is slow, nevertheless, the young shoots suffer equally with the older growth, but from another cause. At an early stage of the growth a fresh enemy appears in the form of a species of *aphis*, a small black fly, almost covering up the points of shoots from sight; these puncture the shoots and leaves, sucking out the sap, and excreting honey-dew in such abundance that the foliage of the tree is shortly black, with the consequent crop of fungus.

"The presence of fungus in the foliage of the orange and other plants is not always to be taken as a sign that *scale* or *fly* is also to be found on the same tree; but may be the result of the ravages of one or other of these parasites on large trees or climbing plants, beneath the shade of which the plants in question may have been growing.

"An extreme example of this has come under my observation this autumn. The foliage of the large oaks in the garden is suffering from a severe attack of *aphis*, so much so, that I have seen the honey-dew *falling in a shower* upon all below, including some hundreds of newly dug orange trees, which had to be at once shifted to more open quarters.

"When scale is present on any tree, there will be found ants in any numbers feeding on the aforesaid sweet matter, and further serving their own ends by transporting the producers of it to fresh feeding grounds."

REMEDY FOR SCALE ON FRUIT TREES.

The following particulars are for an application for the cure of scale on orange trees, camellias, gardenias, apple trees, etc.:

Into a round-bottomed iron pot put eight pounds of soft soap and two quarts of paraffine oil; place the pot over a rather slow fire, consisting of embers only; now with a stout stick vigorously stir the mixture *till the soap has absorbed the whole of the oil;* to the resulting paste add twenty quarts of water, boiling, if convenient; the mixture can now be left to simmer till the whole of the soap is dissolved, the result being a milky fluid, with little or no oil visible on the surface; the pot may now be taken off the fire and stood aside till the liquid is cooled down to about new milk heat. The mixture may now be applied to the infected trees, a garden syringe being used for the purpose; the application should be so managed that every part of the tree may be covered with a thin film of the mixture; to effect this with as little waste as possible, screw on to syringe, before using it, the rose end having the smallest holes; from which drive the mixture with force through and about the foliage and branches of the tree.

When the plants to be dressed are in pots, let the branches of the trees be held over some vessel, such as a tin bath or a packing-case with a zinc lining, in order that waste of the mixture may be avoided as much as possible. Before removing the plants from over the vessel, shake the branches so as to dislodge any superfluous mixture, then place the plants in a horizontal position till nearly dry, and thus prevent the oily matter running down the stems of the plant into the soil.

Any portion of the liquid that may not be used at the time of making will keep good for months; a scum will form on the surface, but that will disappear on again warming and stirring it. This mixture is not at all difficult to concoct, but to insure a good result, it is absolutely necessary to strictly observe the few words printed in italics.

It is hardly necessary to observe that the number of pounds of soap and quarts of paraffine and water are simply quoted as proportions; the number of gallons of mixture made at any one time would be in accordance with the number and size of the trees requiring dressing.

NEW MINERAL LOCALITIES.

By R. T. CROSS.

IN the October number of the *American Journal of Science* there is a description of some interesting minerals found in El Paso County, Colorado. We will briefly mention some of them.

Topaz.—The stone that is cut in Colorado and sold to tourists as topaz is not topaz at all, but simply smoky quartz, or the cairngorm stone of Scotland. Three or four crystals, however, of the genuine precious topaz have been found near Pike's Peak. They are remarkable for size and clearness. The writer owns the smallest and most perfect. It measures about an inch in each direction, and in parts is very clear. The next larger is an inch long and an inch and a half wide and thick, and is of a greenish tinge. The largest is supposed to be a fragment of a crystal a foot long. It is green, and was sent to Denver as a piece of fluor spar.

Phenacite.—This is a very rare mineral, and has not before been found in the United States. Two or three crystals have been found near Pike's Peak. The one described in the *Journal of Science* is owned by the writer of this article. It is about an inch long.

Zircon.—The crystals are found embedded in quartz. They are small but very perfect and clear, highly modified, and of a beautiful color, a reddish brown, inclining to pink or pale honey yellow. In this form it is a secondary gem called hyacinth. Grains of hyacinthian zircon have been found in the sands of Ceylon. Pure kolimite is found with the zircon, also fluorite. The writer has a large number of these zircon specimens for exchange.

Cryolite, Thomsenolite, Gearksulite, etc.—Cryolite and its related minerals are used for the manufacture of alum, soda, etc. It has been found hitherto in only two places in the world, Greenland and the Ural Mountains. The new locality in Colorado is the third, and the first in the United States.

In this interesting locality near Pike's Peak are also found astrophyllite and arfuedsonite, which we think are not found elsewhere in the United States. This is the only locality in the country, so far as we know, for as many as seven different minerals.

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